Report No. UT-14.06

IDENTIFYING POTENTIAL TECHNOLOGICAL AND SERVICE IMPROVEMENTS FOR UDOT TRAFFIC OPERATIONS CENTER

Prepared For:

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Research Division

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RESEARCH

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16. Abstract

Traffic Operation Centers (TOCs) require dedicated management and staff with specialized skills and training. They also rely on advanced technologies and require dedicated operating and capital funding. Each new investment in TOC's technologies and/or services should allow agencies to proactively manage and control traffic in a manner that optimizes the performance of a surface transportation system. The Utah Department of Transportation (UDOT) has commissioned a study to identify potential technological and service improvements for UDOT Traffic Management Center (TMC). The goal of the study is to synthesize the current state of practice on applying innovative and advanced procedures, applications, and tools in operations of TMCs. This report presents outcomes from such a study which was divided into two major phases: a broad web-based survey of the selected agencies and a set of field visits to few of those agencies-leaders in TOC operations. The web based survey was administered through SurveyGizmo during April and May of 2012. Survey contained 22 questions which were developed in accordance with UDOT needs to investigate improvements areas in its TOC operations. After reviewing responses from 54 agencies UDOT technical advisory team selected a list of TMCs which were good candidates to interview during a field visit. Two field-visit tours were organized. The first one was a tour of "Eastern States" TMCs between June 4th and 7th, during which TMCs of following DOTs were visited: Minnesota, Pennsylvania, Ohio, and Virginia. The second tour visited "Western States" TMCs, from July 9th to 11th, when the UDOT team visited California Department of Transportation (CALTRANS) offices in Sacramento and San Francisco and Kansas City SCOUT in Missouri. A literature review of some of the most prominent TMCs in the world shows some interesting international applications which may show directions in which US TMCs will go in near future. The report is summarized through the best TMC practices from the field visits and literature review by providing a comprehensive list of the highlights at the end of the report (Chapter 6).

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UNIT CONVERSION FACTORS

Preferably, present all measurements in the report in inch-pound or U.S. Customary system units. For non-conforming units, give data conversion units in parentheses throughout the report, or include applicable unit conversions here.

(Example) Units used in this report and not conforming to the UDOT standard unit of measurement (U.S. Customary system) are given below with their U.S. Customary equivalents:

- 1 meter (m) = 3.28 feet (ft)
- 1 kilometer (km) = 0.62 mile (mi.)
- Etc.

(Alternatively, the following conversion factors table may be included. Enlarge to fit.)

SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. (Adapted from FHWA report template, Revised March 2003)

LIST OF ACRONYMS

ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
AVL	Automatic Vehicle Locator
BATS	Bus Only Activated Transit Sign
CAC	Congestion Alleviation Control
CAD	Computer aided dispatch done
CALTRANS	California Department of Transportation
CARMA	Corridor Adaptive Ramp Metering Algorithm
CCTV	Closed Circuit Television
CHP	California Highway Patrol
CMAQ	Congestion Mitigation and Air Quality
CMCS	Central Management Computer System
COMET	Corridor Management Teams
CSI	Crime Scene Investigator
DCC	Dublin City Council
DMS	Dynamic Message Sign
DOT	Department of Transportation
DPC	Disaster Prevention Center
DPTIM	Dublin Public Transport Interface Module
ELCS	Electronic Lane Changing System
FHWA	Federal Highway Administration
FIRST	Freeway Incident Response Safety Team
GIS	Geographic Information System
GPRS	General Packet Radio Service
HAR	Highway Advisory Radio
HGV	Heavy Goods Vehicle
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
ICM	Integrated Corridor Management

ICS	Incident Command System
IMT	Incident Management Team
ITS	Intelligent Transportation System
IVR	Interactive Voice Response
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
LRT	Light rail transit
MTC	Metropolitan Transportation Commission
MUTCD	Manual on Uniform Traffic Control Devices
NIMS	National Incident Management System
NTCIP	National Transportation Communications for ITS Protocols
OGL	Operation Green Light
PEMS	Portable Emissions Measurement Systems
PTIPS	Public Transport Information Priority System
RISC	Rapid Incident Scene Clearance
RTA	Roads & Traffic Authority
RTPI	Real-time Passenger Information
RWIS	Road Weather Information System
SAFETEA-LU	Safe, Accountable, Flexible and Efficient Transportation Equity Act: A Legacy for Users
SCATS	Sydney Coordinated Adaptive Traffic System
SHB	Sydney Harbor Bridge
STA	State Transit Authority
STREAM	Strategic Real-time Control for Megalopolis-Traffic
SWARM	System-Wide Adaptive Ramp Metering
TEP	Traffic Emergency Patrol
TIM	Traffic Incident Management
TIMC	Traffic and Incident Management Centre
TMC	Traffic Management Center
TMG	Tokyo Metropolitan Government
TOC	Traffic Operations Center

TOR	Transport Operations Room
UDOT	Utah Department of Transportation
VMS	Variable Message Signs
VSL	Variable Speed Limit

EXECUTIVE SUMMARY

Traffic Operation Centers (TOCs) require dedicated management and staff with specialized skills and training. They also rely on advanced technologies and require dedicated operating and capital funding. Most importantly TOCs face complex institutional issues in coordinating with service providers in response to incidents and they function within environment in which timely responses to external factors are critical. These TOCs' demands and constraints present challenges that agencies face on a daily basis without the benefit of having the necessary resources, experience, skills and training.

One of the most important components of the mitigation measures to face these challenges is a TOC's ability to pursue a wide variety of both proven and innovative strategies and technologies to realize the full potential of the investments. Each new investment in TOC's technologies and/or services should allow agencies to proactively manage and control traffic in a manner that optimizes the performance of a surface transportation system. Investments that allow TOCs to improve the safety, mobility, and productivity of travel also foster economic growth and development of the area under TOC's jurisdiction.

The Utah Department of Transportation (UDOT) has commissioned a study to identify potential technological and service improvements for UDOT Traffic Management Center (TMC). The goal of the study is to synthesize the current state of practice on applying innovative and advanced procedures, applications, and tools in operations of TMCs. Special attention is given to those areas of operations and maintenance which are not thoroughly covered by previous similar surveys and syntheses.

This report presents outcomes from such a study which main purpose was to help UDOT to identify innovative technologies and procedures that can be implemented to advance quality of TOC operations, keep TOC up with its contemporary challenges, and help evolution of TOC into a 'TOC of future'. The project was divided into two major phases: a broad web-based survey of the selected agencies (which run leading TOCs), and a set of field visits to few of those agencies-leaders in TOC operations.

The web based survey was administered through SurveyGizmo from April 10 to May 10, 2012. Survey contained 22 questions which were developed in accordance with UDOT needs to investigate improvements areas in its TOC operations. The surevy was distributed to around 85

agencies throughout the US; out of which 54 provided responses. These responses were summarized in Chapter 2 of this report while individual responses from all participants in the survey are given in the Appendix B.

After reviewing responses from 54 agencies UDOT technical advisory team selected a list of TMCs which were good candidates to interview during a field visit. Two field-visit tours were organized. The first one was a tour of "Eastern States" TMCs between June 4th and 7th, during which TMCs of following DOTs were visited: Minnesota, Pennsylvania, Ohio, and Virginia. The second tour visited "Western States" TMCs, from July 9th to 11th, when the UDOT team visited CALTRANS offices in Sacramento and San Francisco and Kansas City SCOUT in Missouri.

Descriptions of the visited DOTs practices were provided in Chapters 3 and 4 of this report with highlights from each visit following the description of practices from each visited site. Chapter 5 contains literature review which describes TMC practices and features of some of the most prominent TMCs around the world. A list of descriptions from international experiences shows that the US counterparts are keeping the pace with the rest of the world but it also shows some very interesting applications which may show in which directions will US TMCs develop in future years. Finally, a comprehensive list of the highlights from all visited TMCs is provided as a separate Chapter 6 at the end of the report.

1.0 INTRODUCTION

1.1 Background

Traffic Operation Centers (TOCs) are a key tool that public agencies use to monitor and report on roadway and travel conditions, coordinate with local interests in response to changing conditions, and proactively manage and control traffic to mitigate the impacts of congestion and improve the reliability of travel. TOCs also play a critical role in coordinating, supporting and sharing such information to the traveling public.

TOCs require dedicated management and staff with specialized skills and training. They also rely on advanced technologies and require dedicated operating and capital funding. Most importantly TOCs face complex institutional issues in coordinating with service providers in response to incidents and they function within environment in which timely responses to external factors are critical. These TOCs' demands and constraints present challenges that agencies face on a daily basis without the benefit of having the necessary resources, experience, skills and training.

One of the most important components of the mitigation measures to face these challenges is a TOC's ability to pursue a wide variety of both proven and innovative strategies and technologies to realize the full potential of the investments. Each new investment in TOC's technologies and/or services should allow agencies to proactively manage and control traffic in a manner that optimizes the performance of a surface transportation system. Investments that allow TOCs to improve the safety, mobility, and productivity of travel also foster economic growth and development of the area under TOC's jurisdiction.

1.2 Problem Statement

The Utah Department of Transportation (UDOT) has commissioned a study to identify potential technological and service improvements for UDOT Traffic Management Center (TMC). The goal of the study is to synthesize the current state of practice on applying innovative and advanced procedures, applications, and tools in operations of TMCs. Special attention is given to those areas of operations and maintenance which are not thoroughly covered by previous similar surveys and syntheses.

1.3 Objectives

UDOT is continuously facing the need to manage evolution of its TOC based on the desire to expand its functionalities, share information electronically with stakeholders, replace outdated technologies, expand the area of coverage, and meet the continuously changing needs. The main purpose of this project is to help UDOT to identify innovative technologies and procedures that can be implemented to advance quality of TOC operations, keep TOC up with its contemporary challenges, and help evolution of TOC into a 'TOC of future'. It is proposed that the project has two major phases: a broad web-based survey of the selected agencies (which run leading TOCs), and a set of field visits to few of those agencies-leaders in TOC operations.

1.4 Outline of Report

The rest of the report is organized as follows. Chapter 2 describes the overview of the survey together with summarized results of all survey responses. Chapter 3 covers field visits made during a tour of TMCs in "Eastern States". Chapter 4 describes field visits made during a tour of TMCs in "Western States". Chapter 5 summarizes the highlights from all of the field visits of TMCs. Appendix A displays the format of the web-based questionnaire. Appendix B lists all of the survey responses from the web-based survey. Appendix C shows additional documents uploaded by respondents during completion of the web-based survey.

2.0 SURVEY QUESTIONS AND RESPONSES

2.1 Overview

In this chapter, questions from an online survey about TMCs are listed and after each question, responses from agencies are summarized in forms of graphs and tables. Please note that some of the answers are in such form that they cannot be easily summarized; thus in such cases readers are referred to find specific answers in Appendix B.

As a part of work tasks defined by research team, survey with the questions covering several important issues of UDOT's concern was developed. The final version of the survey is a result of several iterations with UDOT staff, which helped to develop a better survey that will exactly answer UDOT's current needs. A list of potential TOC agencies that should be surveyed was created by conducting comprehensive online research. The survey was initially sent to more than 85 recipients out of which 54 provided responses. The list of invited participants/ agencies was reviewed by UDOT staff to ensure that all the relevant agencies countrywide are taken in consideration.

Survey for this project was administered through SurveyGizmo web tool. Survey contained 22 questions in total and it was open for respondents from April 10 until May 10 of 2012. During this period multiple reminder emails were sent to the list of the invited agencies to increase the response rate. Following summarizes questions and answers from the survey.

As an introductory question, agencies were asked to provide contact information of the person who responded to the survey: name of the person, name of the organization, position of the person, address, phone, fax, and email (see Table 2.1).

Table 2.1 Participating Agencies

Name	Organization	Position	Address	Phone	Fax	Email
Robert L. Trachy Jr.	VA DOT-Operations and Security Division	Acting Assistant Division Administrator	1221 East Broad Street	804-371-6825	804-692-0810	Larry.Trachy@VDOT.Virginia.gov
Jonathan Nelson	Lake County Division of Transportation	Engineer of Traffic	600 West Winchester Rd, Libertyville, IL 60048	847-377-7400		jpnelson@lakecountyil.gov
Dan Herstine	Rhode Island DOT TMC	Consultant	2 Capitol Hill, Providence, RI 02903	401-222-5826 x4186	401-222-4225	daniel.herstine@jacobs.com
Rod Mead	Colorado DOT TMC	Operations Manager	425-C Corporate Cir. Golden, CO. 80033	303/512-5822		Rod.Mead@dot.state.co.us
Jim Larsen	Ada County Highway District	ITS Manager	3775 Adams Street	208-387-6196		jlarsen@achdidaho.org
Stephen Glascock	Louisiana DOTD	ITS Director	1212 East Highway Drive, Baton Rouge, LA 70802	225-379-2516	225-378-2521	stephen.glascock@la.gov
George Saylor, P.E.	Ohio DOT	Sr. ITS Engineer	1980 W. Broad St., Floor 3, Columbus, OH 43223	614-752-8099	614-644-8199	george.saylor@dot.state.oh.us
Raymond Hallavant	TDOT Region 3	TMC Operations Manager	6603 Centennial Blvd, Nashville Tennessee	615.350.3437	615.350.3384	raymond.hallavant@tn.gov

			37243			
Jim Kranig	Minnesota DOT	Metro Regional TMC Engineer	1500 West County Road B2, Roseville, MN 55113	651.234.7020	651.234.7006	jim.kranig@state.mn.us
Bob Koeberlein	Idaho Transportation Department	Mobility Services Engineer	PO Box 7129, Boise, ID 80707	208 334 8487		robert.koeberlein@itd.idaho.gov
Mike Jenkinson	California DOT	HQ TMC Manager	1120 N Street MS 36, Sacramento Ca 95814	916 654 6912		mjenkins@dot.ca.gov
Tony Sheppard	South Carolina DOT	Director of Traffic Engineering	955 Park Street	803-737-1462		sheppardts@scdot.org
Sarah Tracy	Nebraska Department of Roads	ITS Engineer	5001 S. 14th Street, Lincoln, NE 68509	402.479.4771		sarah.tracy@nebraska.gov
Ken DePinto	Colorado DOT	ITS Branch Manager	425 Corporate Circle	303-512-5820		ken.depinto@dot.state.co.us
Bruce E. Kenney III, P.E.	West Virginia Division of Highways	ITS Coordinator /Systems Management Engineer	1900 Kanawha Blvd East	304-558-9449	304-558-1209	bruce.e.kenney@wv.gov
Robert J. Rella, PE, PTOE	NYSDOT	Manager - Hudson Valley TMC	200 Bradhurst Avenue, Hawthorne, NY	914-742-6010	914-742-6011	brella@dot.state.ny.us

			10532			
Jason M. Previte	PennDOT - Engineering District 11-0	Regional TMC Manager	45 Thoms Run Rd, Bridgeville, PA 15017	412-429-6034	412-429-3811	jprevite@pa.gov
Giri Jeedigunta P.E.	Palm Beach County Traffic Division	Signal Systems Manager	2300 N. Jog Rd, West Palm Beach, FL 33411	561-684-4030	561-78-5770	gjeedigu@pbcgov.org
Peter Vega	Florida DOT	Intelligent Transportation Systems Engineer	2198 Edison Avenue, Jacksonville, FL 32204	904-360-5463		peter.vega@dot.state.fl.us
John v. Nelson	Colorado DOT	ITS Operation Manager	425 C Corporate Circle Golden Colorado 80401	303-512-5838		john.nelson@dot.state.co.us
Doug Maas	Sacramento County Department of Transportation	Senior Transportation Engineer	9630 Conservation Road	916-875-5545	916-876-5355	maasd@saccounty.net
Javier Rodriguez	Florida DOT	ITS Operations Engineer	1001 NW 111 Avenue, Miami, FL 33172	3056407307		javier.rodriguez2@dot.state.fl.us
Dong Chen	FDOT District 4	District ITS Program Manager	2300 West Commercial Blvd., Ft Lauderdale, FL 33309	954-847-2796		dong.chen@dot.state.fl.us

Eloy Lee	Miami-Dade Public Works & Waste Management	Traffic Signals System Manager	7100 NW 36 ST	305-592-8925 ext 243		leee@maimidade.gov
Brian Kary	Minnesota Department of Transportation	Freeway Operations Engineer	1500 West County Rd B2, Roseville, MN 55113	651-234-7022	651-234-7023	brian.kary@state.mn.us
Joe Baltazar	Caltrans	TMC Operator / Transportation Engineer (Civil)	1657 Riverside Dr, Redding CA 96001	530-225-3206	530-225-3261	Joseph_Baltazar@dot.ca.gov
Mike Juliano	NJDOT	Manager (TOC North / STMC)	King Georges Post Road, Woodbridge, NJ 07059	732-442-8600 Ex 5310	732-293-1102	michael.juliano@dot.state.nj.us
Christopher E. Kibler	City of Orlando	Signal Systems Engineer	400 S. Orange Avenue, Orlando, FL, 32801	321.235.5350	407.249.4606	chris.kibler@cityoforlando.net
Mark Demidovich	Georgia DOT	Assistant State Traffic Engineer	935 E Confederate Ave Bldg 24 Atlanta, GA 30316	404-635-2838	404-635-8001	mdemidovich@dot.ga.gov
Scott Kozlik	Wisconsin DOT	Freeway Operations Technician	433 W St. Paul Ave, STE 300, Milwaukee, WI 53203	414-227-2161	414-227-2165	scott.kozlik@dot.wi.gov
Hilary Owen	Michigan DOT	System Operations Engineer	425 W Ottawa, Lansing MI 48909	517-335-2049		owenh2@michigan.gov

Jim Hilbert	Florida's Turnpike Enterprise	TMC Program Manager	Mile Post 263, Florida's Turnpike, Ocoee, FL 34761	407-264-3312	407-822-4902	jdhdmh74@yahoo.com
David E. Fink, P.E.	TxDOT - Houston District	Assistant Manager TMC - Houston District	6922 Katy Rd, Houston, Texas 77024	713-881-3063	713-881-3028	david.fink@houstontranstar.org
Robert Reck	Pasco County Traffic Operations	Traffic Operations Manager	7536 State St. New Port Richey, Fl. 34654	727-847-8139	727-815-7014	rreck@pascocountyfl.net
Salvador Perez	TxDOT	Engineering Assistant	13301 Gateway Boulevard West	915-790-4335	915-790-4424	salvador.perez@txdot.gov
Brian Burk	TxDOT	Transportation Engineering Supervisor	7901 n. ih 35, austin, tx 78753	5129740899	5129740865	brian.burk@txdot.gov
Gene S. Donaldson	Delaware DOT	TMC Operations Manager	169 Brick Store Landing Road, Smyrna, DE 19977	302-659-4601	302-659-6128	gene.donaldson@state.de.us
E. Jason Sims	Kansas City Scout	Traffic Manager Center Director	600 NE Colbern RD, Lee's Summit MO 64086	8163472200	8166226550	jason.sims@modot.mo.gov
Dennis Mitchell	Oregon DOT	Region Traffic Engineer	123 NW Flanders	503-731-8218		dennis.j.mitchell@state.or.us

Brandi Hamilton	Montana DOT	Maintenance Business Operations Supervisor	2701 Prospect Avenue Helena MT 59620	406 444 0468		brhamilton@mt.gov
Mike Stokes	Mississippi DOT	ITS Program Manager	P.O. Box 1850, Jackson MS 39215-1850	601-359-9710	601-359-5918	mstokes@mdot.state.ms.us
Debbie Albert	City of Glendale	Principal Traffic Engineer	5800 West Glenn Drive, Suite 315	623-847-5724		dalbert@glendaleaz.com
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Ramin Ghodsi	CALTRANS	TEE	13892 Victoria Street, Fontana, CA 92336	909-356-3729		ramin_ghodsi@dot.ca.gov
Michael Wendtland	Southern TOC: Tucson, AZ	Engineer Manager	2590 South Santa Cruz Lane	520 624 1200		michael@itsengineers.com

Michael Kehoe	Amey, Birmingham, UK	Senior ITS Engineer	International Design Hub, Colmore Plaza,20 Colmore Circus, Birmingham,B4 6AT	7801987481		michael.kehoe@amey.co.uk
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David Swift Hoadley	Department of Transport and Main Roads	Manager (Statewide TMC)	Ground Floor | Nerang TMC | 16-18 White Street | Nerang Qld 4211	437530871	(07) 55969511	david.a.swift-hoadley@tmr.qld.gov.au

The rest of the survey responses are grouped into separate thematic parts as follows:

- Control room operations
- Operational issues

- Incident management
- Travel information system
- Institutional collaboration
- Maintenance of existing system
- Emergency preparedness
- Inclement weather operations
- TOC policies
- Others

2.2 Control Room Operations

Four questions regarding control room operations were part of the survey:

1. What software is used to control or manage each of the following? Outline of answers offered is shown in Figure 2.1.


Video control
Dynamic (Variable) Message Signs
Highway Advisory Radio (HAR)
Traffic signal control
Managing/ tackling incidents and special events

Figure 2.1 Control Room Operations

Table 2.2 summarizes responses from 54 agencies.

Table 2.2 Summary of TOCs Control/Managing Software

Organization	Video control	Dynamic (Variable) Message Signs	HAR	Traffic signal control	Managing/ tackling incidents and special events
VA DOT-Operations and Security Division	/	/	/	/	/
Lake County Division of Transportation	Delcan solution (JAVA & VLC)	Delcan solution	Delcan solution (with Wizzard text to speech)	Econolite Centracs	Delcan Solution
Rhode Island DOT TMC	Aimetis Symphony	Daktronics Vanguard	Vaisala Platinum	Not controlled by TMC	Custom built SQL database called RhodeWAYS
Colorado DOT TMC	Camera Chameleon (360 Surveillance)	In house designed software	N/A	N/A	In house designed software
Ada County Highway District	IBI Group ATMS	IBI Group ATMS	IBI Group ATMS	Naztec Nema (atms.now software)	IBI Group ATMS
Louisiana DOTD	360 Surveillance	360 Surveillance	Vendor-supplied	Streetwise	Self-developed TIM database and CARS for 511
Ohio DOT	Cisco VSOM & In-House App (BuckeyeTraffic)	In-House App (BuckeyeTraffic)	In-House App (BuckeyeTraffic)	Siemens TACTICS	In-House App (BuckeyeTraffic)
TDOT Region 3	Video pro by Protronics	Ledstar/Daktonic	HIS Platinum	None	IM/LOCATE In House/Gannet Fleming developement
Minnesota DOT	Direct connection of keyboard/joy stick to video switcher (can also run through IRIS)	IRIS (Intelligent Roadway Information System)	Have contract with Minneapolis Public School System FM Radio Station for long format traffic reports		IRIS

Organization	Video control	Dynamic (Variable) Message Signs	HAR	Traffic signal control	Managing/ tackling incidents and special events
Idaho Transportation Department	Bosch	IBI	IBI	Centracs	CARS
California DOT	Delcan ATMS, ICX Cameleon, Locally developed SOCCs	Delcan ATMS, ICX Cameleon, Locally developed SOCCs	Manufacture systems	Caltrans developed	Delcan ATMS, TMCAL,
South Carolina DOT	Siemens	Siemens	Siemens	Naztec	Siemens
Nebraska Department of Roads	Delcan NETworks ATMS software	Delcan NETworks ATMS software	N/A (no HAR)		Delcan NETworks ATMS software
Colorado DOT	360 Surveilance Camera Camillion	Custom software called CTMS	None	None at the TOC	Custom software called CTMS
West Virginia Division of Highways	OPENTMS	OPENTMS	None	CENTRACS, MARC	OPENTMS
NYSDOT	Cameleon	Vanguard	OEM	N/A	TransCommander , OpenReach
PennDOT - Engineering District 11-0	Custom ATMS Software developed by AECOM	Custom ATMS Software developed by AECOM	HIS Platinum	N/A	Road Condition Reporting System/ATMS
Palm Beach County Traffic Division	Watchdog (by Coretec) & KITS	N/A	N/A	ATMS.now (by NAZTEC)	In a limited scope through CCTV; more frequently from Fire Rescue Live Scanner; Organizers will be responsible for providing information on special events, except for a few predictable and recurring events, where special timing plans have

Organization	Video control	Dynamic (Variable) Message Signs	HAR	Traffic signal control	Managing/ tackling incidents and special events
					been developed for implementation
Florida DOT	SunGuide w/ Activu module	SunGuide	SunGuide	Naztec ATMS.now	SunGuide
Colorado DOT	Panasonic/Camera Chameleon	In house developed software	N/A	N/A	In house developed software
Sacramnto County Department of Transportation	Genetec Omnicast 4.7 through Centracs	Centracs from Econolite	N/A	Centracs	Centracs for management Access for logging
Florida DOT	SunGuide Software	SunGuide Software	Vendor Provided Software	N/A	SunGuide Software
FDOT District 4	SunGuide software	SunGuide software	SunGuide software	N/A	SunGuide software
Miami-Dade Public Works & Waste Management	/	/	/	Bitran233, KITS	/
Minnesota Department of Transportation	Pelco Switcher	IRIS	N/A	/	Integraph CAD (shared with State Patrol)
Caltrans	Satellite Office Command Center (SOCCS), soon to cut over to Intelligent Roadway Information System (IRIS)	Satellite Office Command Center (SOCCS), soon to cut over to Intelligent Roadway Information System (IRIS)	Vaisala / HIS Communication Control	N/A	Lane Closure System (LCS)
NJDOT	Genetec	MIST	N/A	Streetwise	SWIFT / Openreach

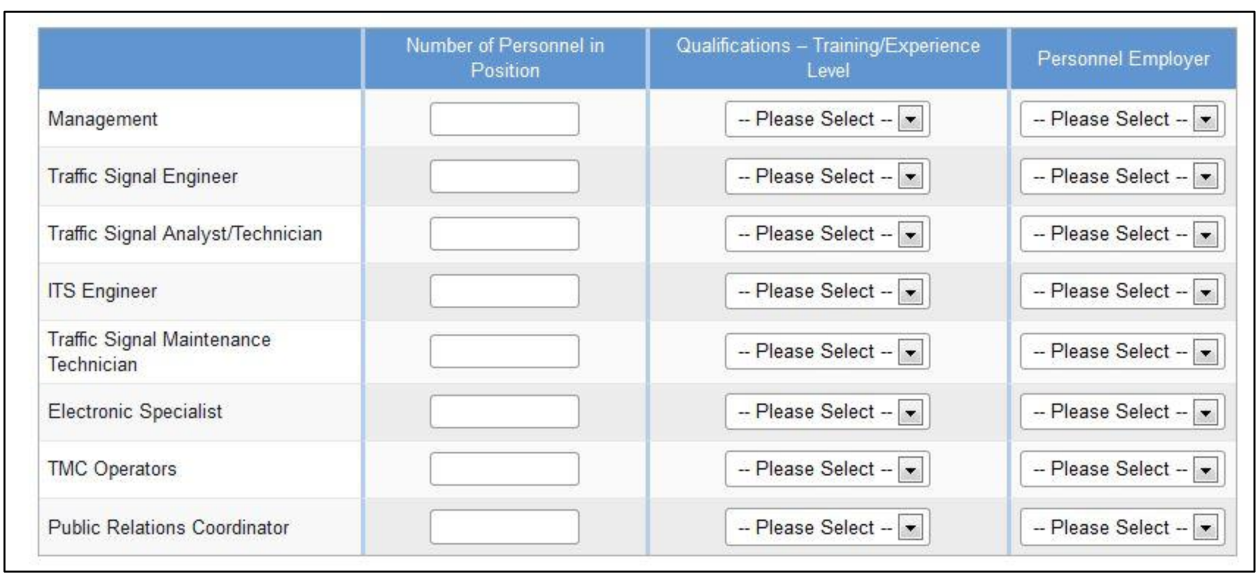
Organization	Video control	Dynamic (Variable) Message Signs	HAR	Traffic signal control	Managing/ tackling incidents and special events
City of Orlando	Cameleon ITS (ICX)	Vanguard (Daktronics)	N/A	ATMS.now (Naztec)	All of the above
Georgia DOT	Delcan Intelligent Networks	Delcan Intelligent Networks	N/A	TACTICS (Siemens)	Delcan Intelligent Networks
Wisconsin DOT	Teleste	TransSuite	TransSuite	TransSuite	TransSuite
Michigan DOT	ATMS	ATMS	N/A	N/A	ATMS
Florida's Turnpike Enterprise	Cell Stack	SunGuide	/	None	SunGuide
TxDOT - Houston District	TxDOT Lonestar	TxDOT Lonestar	/	Siemens I2	AECOM developed Webbase Software
Pasco County Traffic Operations	Cameleon ITS	Vanguard	N/A	SCATS	/
TxDOT	Lonestar (Developed for TxDOT)	Lonestar (Developed for TxDOT)	DR2000 Platinum	Naztec Streetwise	Lonestar (Developed for TxDOT)
TxDOT	Javelin Quest, TxDOT Lonestar, TxDOT ATMS	Vendor application, TxDOT Lonestar	Vaisala	Not managed at TMC	TxDOT Lonestar
Delaware DOT	VSOM	Open Roads	Audacity	Siemens Actra (transitioning to Siemens Tactics)	Electronic Operations (EOP) (Developed in house)
Kansas City Scout	TransCore Transuite	TransCore Transuite	TransCore Transuite	TransCore Transuite	TransCore Transuite
Oregon DOT	ATMS (Delcan)	ATMS (Delcan), Skyline	/	Transuite, Voyage	TOCS - developed by ODOT
Montana DOT	SSI	Intelligent Control	Vendor software	/	/

Organization	Video control	Dynamic (Variable) Message Signs	HAR	Traffic signal control	Managing/ tackling incidents and special events
Mississippi DOT	Delcan	Delcan	Delcan	ACTRA/TACTICS	Delcan
City of Glendale	Cameleon ITS	Cameleon ITS, Vanguard, Skyline, and ADDDCO Brick Software	N/A	KITS	N/A
Town of Gilbert	Cameleon 360	On site programing	N/A	Siemens I2	N/A
Boston Transportation Department	Pelco Switch/Genetec Software	/	/	Custom Software based on UTCS	Email alerts
Caltrans	Advanced Traffic Management System (ATMS)	ATMS	HIS Platinum	ATMS / RMIS (ramp meters only) others not controlled from TMC	ATMS / TMCAL
CALTRANS	ATMS	ATMS	HIS PLATINUM	(Ramp Meters Only) ATMS/RMIS	ATMS/TMCAL
Southern TOC: Tucson, AZ	Camera Cameleon	Camera Cameleon	None	I2	HCRS
Birmingham, UK	Sistor AX Siemens CCTV and BARCO video wall	Techspan and VMSL fed into a Common Database	/	SCOOT/UTC/RMS fed into a Common Database	Common Database (ENVITIA)
Transport for NSW, Australia	Custom built software but investigating Genetec Security Center	CMCS - system owned and developed by us.	None	SCATS	CMCS - system owned and developed by us.
NMDOT	Control Point / Jupiter	Skyline	Platinum	Centracs (Not Managed by NMDOT-TMC)	NMroads admin (internal ATIS / 511 application)
Manatee County	Cameleon	Dactronix	N/A	Naztec's ATMS.now	Cartegraph

Organization	Video control	Dynamic (Variable) Message Signs	HAR	Traffic signal control	Managing/ tackling incidents and special events
Trafficware	GE/Kalatel control with Matrix Swith	N/A	N/A	ATMS.now	New .NET program
Department of Transport and Main Roads	DVTel	Streams	N/A	Streams	Sims

2. What is the classification of your operators? If it is more convenient, organizational chart and position description may be an alternative (agencies were able to upload organizational chart optionally).

Figure 2.2 displays the question as provided on the website. Respondents had to input number of personnel in appropriate position, select one of the available answers regarding qualifications needed for specific position (low, medium, high), and note who is in charge of personnel employed for each position (state or contractor). Optional part of this question was to upload an organizational chart and position description. Outline of available answers is shown in Figure 2.2.



	Number of Personnel in Position	Qualifications – Training/Experience Level	Personnel Employer
Management		-- Please Select --	-- Please Select --
Traffic Signal Engineer		-- Please Select --	-- Please Select --
Traffic Signal Analyst/Technician		-- Please Select --	-- Please Select --
ITS Engineer		-- Please Select --	-- Please Select --
Traffic Signal Maintenance Technician		-- Please Select --	-- Please Select --
Electronic Specialist		-- Please Select --	-- Please Select --
TMC Operators		-- Please Select --	-- Please Select --
Public Relations Coordinator		-- Please Select --	-- Please Select --

Figure 2.2 Control Room Operations.

Based on the available responses charts and tables are plotted to show the summary of the results. Figure 2.3 shows the share of training/experience levels of an electronic specialist in TOCs which responded to the survey. In total, 26 responses were recorded for this position. Table 2.3 shows summary of responses.

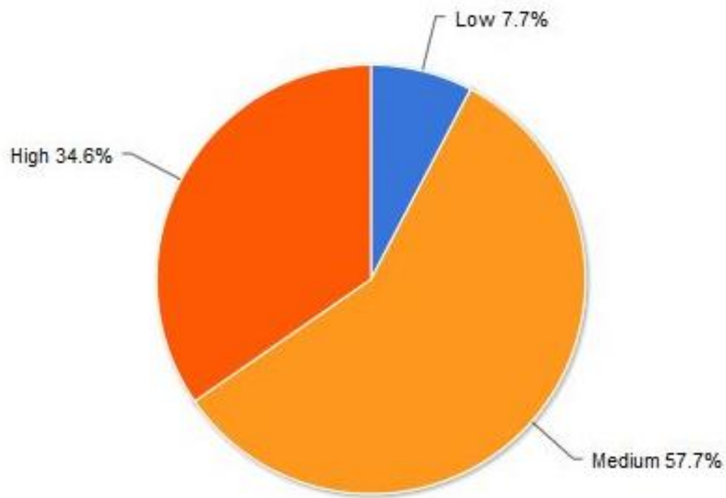


Figure 2.3 Electronic Specialist Training/Experience Level

Table 2.3 Electronic Specialist Position - Summary

Qualification Level	Number of responses	Percent (%)
Low	2	7.7
Medium	15	57.7
High	9	34.6
Total	26	100

Figure 2.4 shows the share of training/experience levels of an Intelligent Transportation Systems (ITS) Engineer in TOCs which responded to the survey. In total, 26 responses were recorded for this position. Table 2.4 shows summary of the responses.

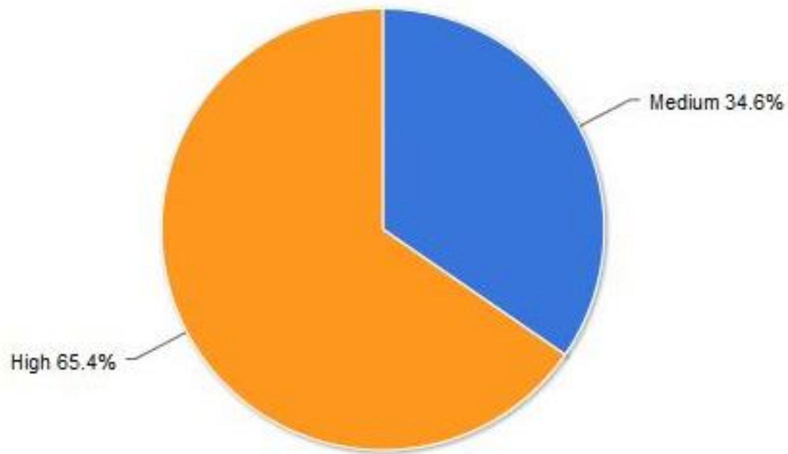


Figure 2.4 ITS Engineer Training/Experience Level

Table 2.4 ITS Engineer - Summary

Qualification Level	Number of responses	Percent (%)
Low	0	0.0
Medium	9	34.6
High	17	65.4
Total	26	100

Figure 2.5 shows the share of training/experience levels of a management in TOCs which responded to the survey. In total, 40 responses were recorded for this position. Table 2.5 shows summary of the responses.

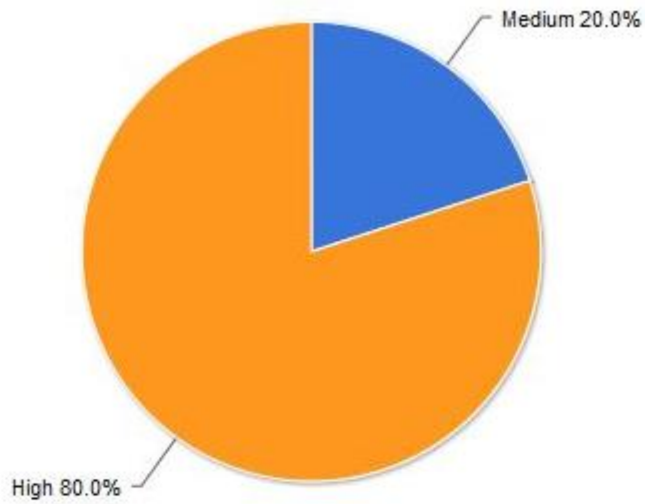


Figure 2.5 TOCs Management Training/Experience Level

Table 2.5 TOCs Management - Summary

Qualification Level	Number of responses	Percent (%)
Low	0	0.0
Medium	8	20.0
High	32	80.0
Total	40	100

Figure 2.6 shows the share of training/experience levels of a public relations coordinator in TOCs which responded to the survey. In total, 19 responses were recorded for this position. Table 2.6 shows summary of the responses.

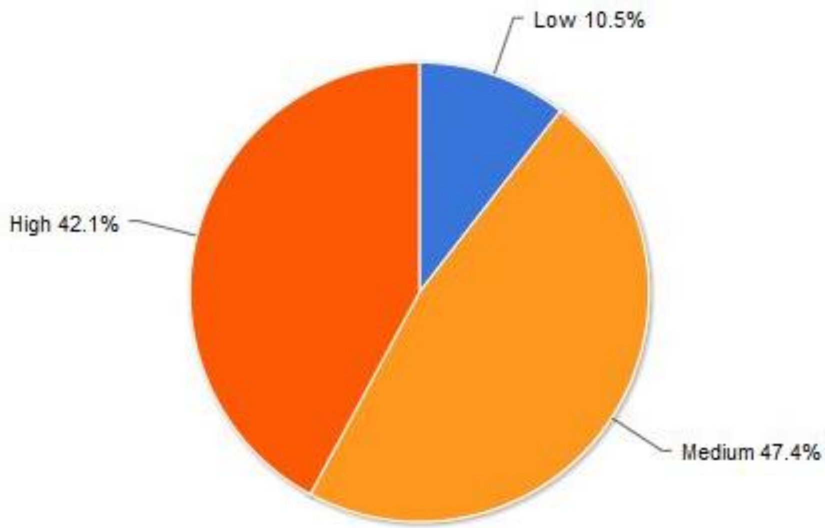


Figure 2.6 Public Relations Coordinator Training/Experience Level

Table 2.6 Public Relations Coordinator - Summary

Qualification Level	Number of responses	Percent (%)
Low	2	0.0
Medium	9	20.0
High	8	80.0
Total	19	100

Figure 2.7 shows the share of training/experience levels of TOCs operators. In total, 36 responses were recorded for this position. Table 2.7 shows summary of responses.

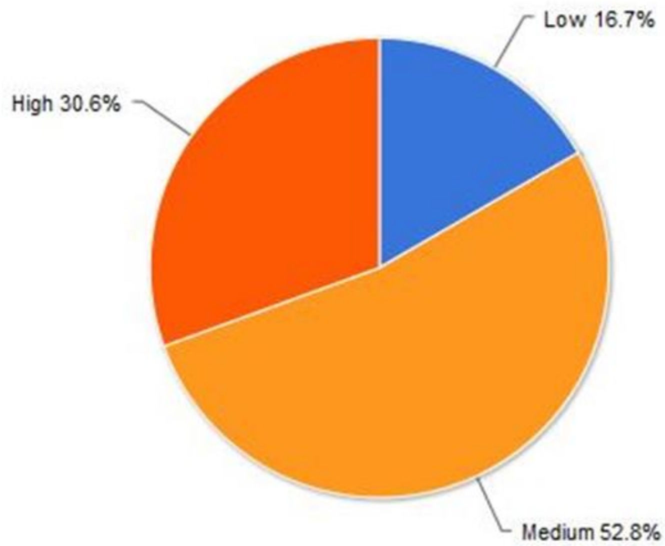


Figure 2.7 TOCs Operators Training/Experience Level

Table 2.7 TOCs Operators - Summary

Qualification Level	Number of responses	Percent (%)
Low	6	16.7
Medium	19	52.8
High	11	30.6
Total	36	100

Figure 2.8 shows the share of training/experience levels of traffic signal analyst or technicians. In total, 26 responses were recorded for this position. Table 2.8 shows summary of the responses.

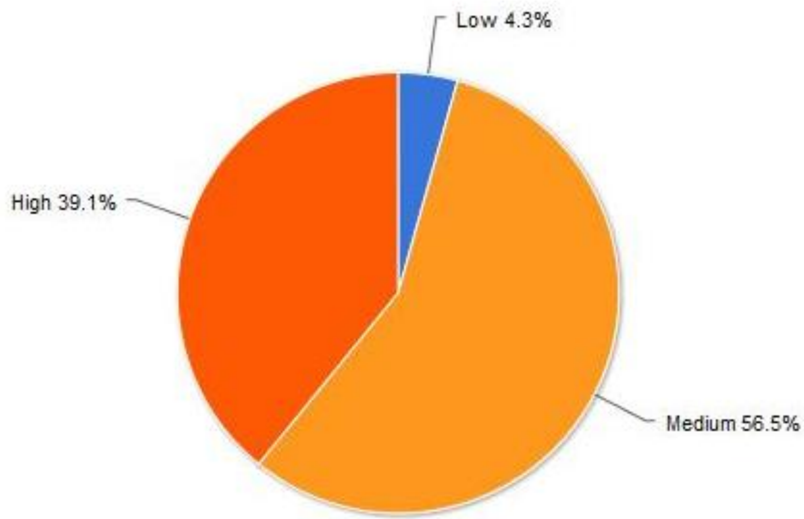


Figure 2.8 Traffic Signal Analyst/Technician Training/Experience Level

Table 2.8 Traffic Signal Analyst - Summary

Qualification Level	Number of responses	Percent (%)
Low	1	4.3
Medium	13	56.5
High	9	39.1
Total	23	100

Figure 2.9 shows the share of training/experience levels of a traffic signal engineer. In total, 24 responses were recorded for this position. Table 2.9 shows summary of the responses.

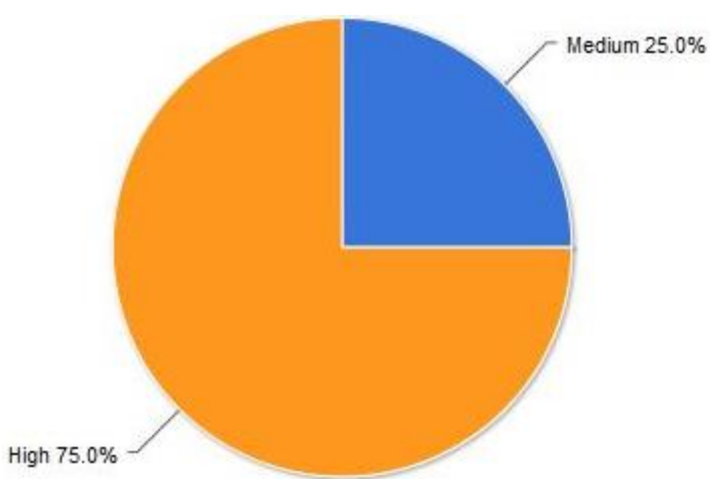


Figure 2.9 Traffic Signal Engineer Training/Experience Level

Table 2.9 Traffic Signal Engineer - Summary

Qualification Level	Number of responses	Percent (%)
Low	0	0.0
Medium	6	25.0
High	18	75.0
Total	24	100

Figure 2.10 shows the share of training/experience levels of a traffic signal maintenance technician. In total, 24 responses were recorded for this position. Table 2.10 shows summary of the responses.

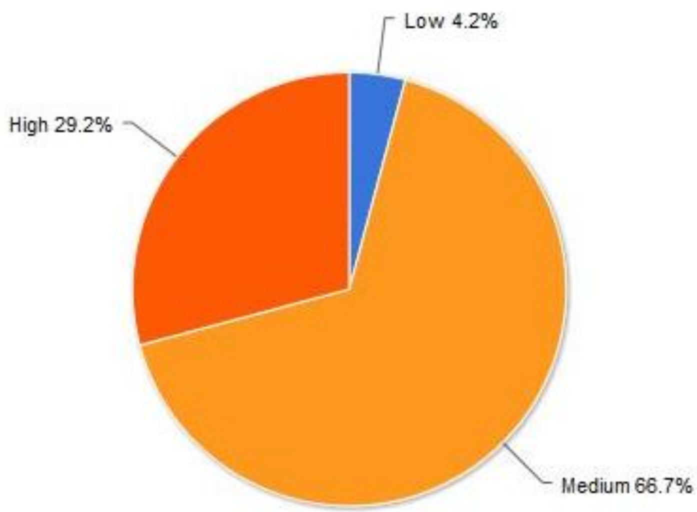


Figure 2.10 Traffic Signal Maintenance Technician Training/Experience Level

Table 2.10 Traffic Signal Maintenance Technician - Summary

Qualification Level	Number of responses	Percent (%)
Low	1	4.2
Medium	16	66.7
High	7	29.1
Total	24	100

Figure 2.11 shows share of personnel employer in the agencies which responded to the survey. Agencies were able to choose between contractor and state employee. Table 2.11 shows summary of the responses.

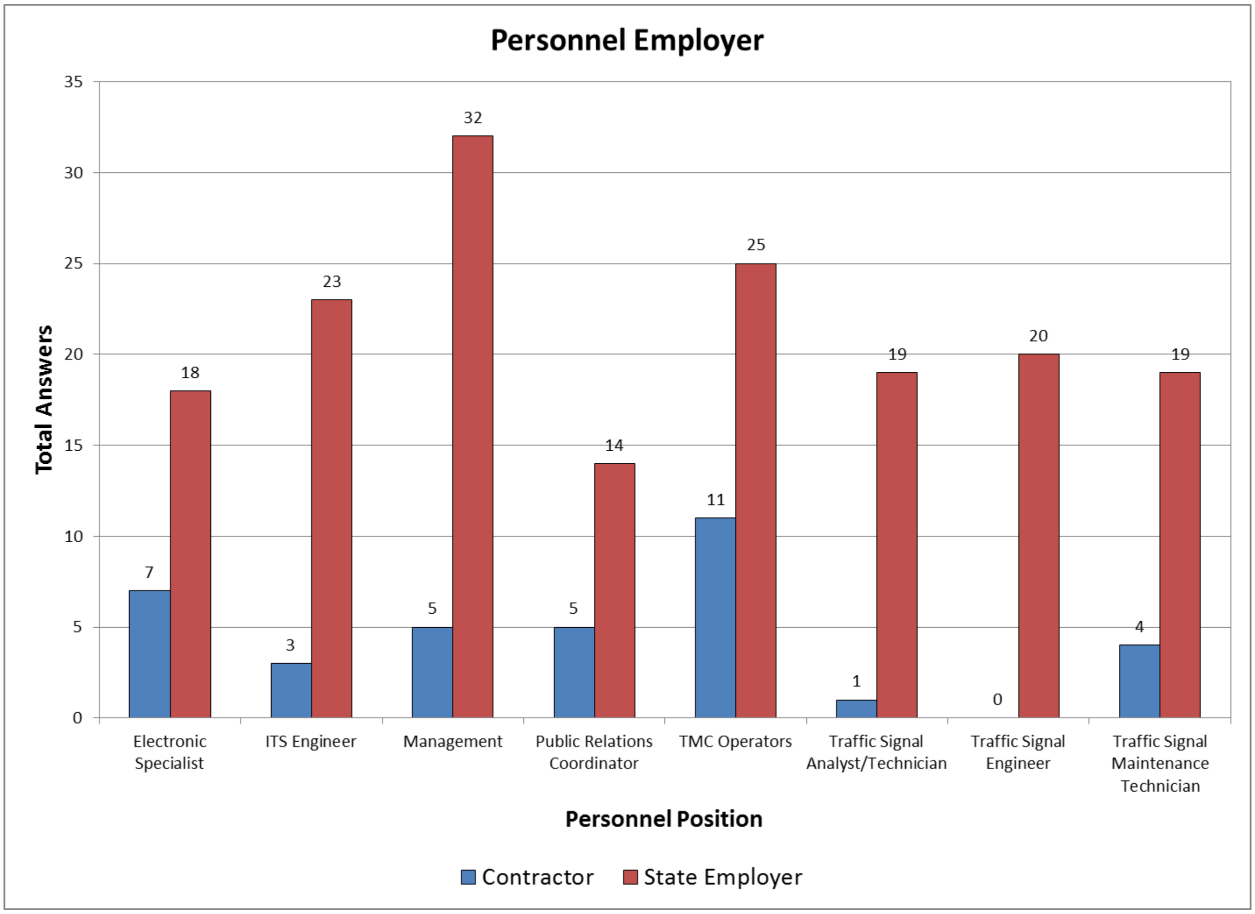


Figure 2.11 Personnel Employer Distribution

Table 2.11 Personnel Employer - Summary

Personnel Position	Personnel Employer		Number of total responses
	Contractor	State Employer	
Electronic Specialist	7	18	25
ITS Engineer	3	23	26
Management	5	32	37
Public Relations Coordinator	5	14	19
TMC Operators	11	25	36
Traffic Signal Analyst/Technician	1	19	20
Traffic Signal Engineer	0	20	20
Traffic Signal Maintenance Technician	4	19	23

3. Do you receive computer aided dispatch (CAD) data from 911 dispatch centers? Outline of the available answers is shown in Figure 2.12.

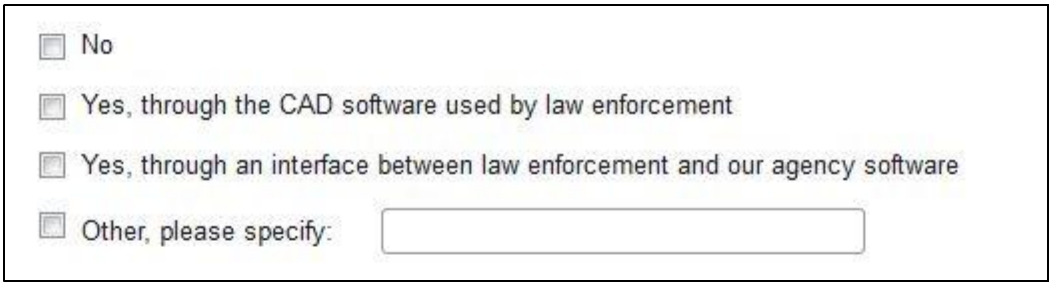

- [ ] No
- [ ] Yes, through the CAD software used by law enforcement
- [ ] Yes, through an interface between law enforcement and our agency software
- [ ] Other, please specify:

Figure 2.12 Control Room Operations – CAD Data

Figure 2.13 shows how TOCs receive CAD data from 911 dispatch centers. Table 2.12 shows summary of the responses.

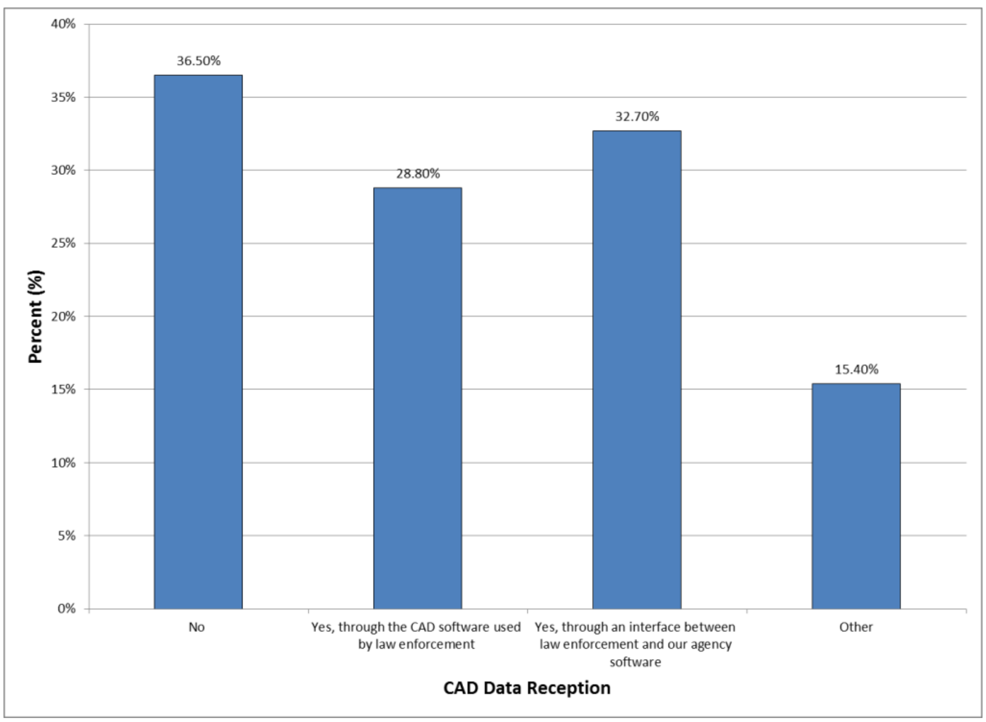


Figure 2.13 CAD Data Reception from 911 Dispatch Center

Table 2.12 CAD Data Reception from 911 Dispatch Centers - Summary

CAD data reception	Number of responses	Percent (%)
No	19	36.5
Yes, through the CAD software used by law enforcement	15	28.8
Yes, through an interface between law enforcement and our agency software	17	32.7
Other	8	15.4

4. Have you upgraded your projection video wall since the opening of the TMC? Outline of the available answers is shown in Figure 2.14.

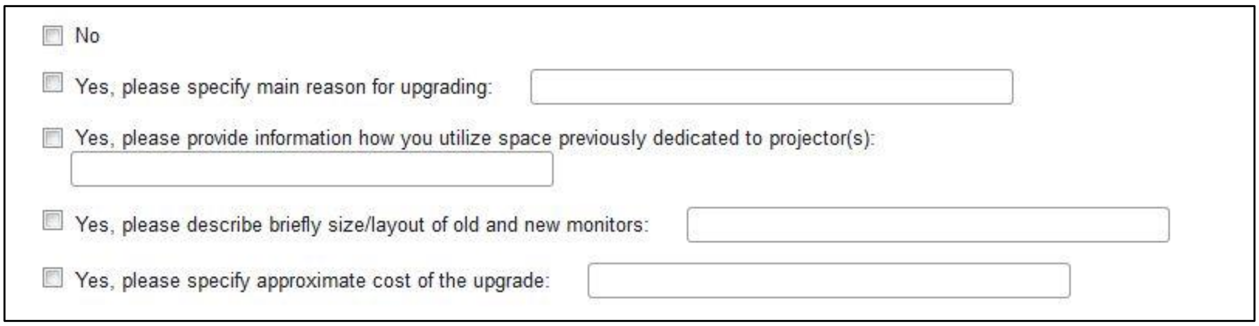


Figure 2.14 Control Room Operations – Video Wall

Table 2.13 shows summary of all the responses that the transportation agencies provided. In total, 42 agencies/TOCs responded to this question.

Table 2.13 Control Room – Responses Summary

Organization \ Response	No	Yes, please specify main reason for upgrading	Yes, please provide information how you utilize space previously dedicated to projector(s)the TMC?	Yes, please describe briefly size/layout of old and new monitors	Yes, please specify approximate cost of the upgrade
Virginia DOT - Operations and Security Division	No				
Lake County Division of Transportation	No				
Rhode Island DOT TMC		Old BARCO system failed, did not support IP cameras		Old system was 2 projectors for two 4x4 matrixes of cameras. New systems is 8 rear projection cubes to display same cameras	Approximately $400,000
Colorado DOT TMC	No				
Ada County Highway District		Outdated video wall needs upgrade			We will upgrade wall in 2012 to flat screens. Cost is $150,000
Louisiana DOTD		Product end of life			
Ohio DOT	No				
TDOT Region 3		Previous video wall was analog. No longer supported. Parts could not be located.		New ones are approximately same size as old, just a few inches larger. Entire wall comprised of 18 Cubes all the same dimensions that complete a video wall of 7'.5"" high X 20' wide	Approximately $1,200,000
Minnesota DOT		Original monitors were CRT and projection devices that reached service life and replaced with flat screen monitors			
Idaho Transportation Department		Added 8 monitors			$450,000

Organization / Response	No	Yes, please specify main reason for upgrading	Yes, please provide information how you utilize space previously dedicated to projector(s)the TMC?	Yes, please describe briefly size/layout of old and new monitors	Yes, please specify approximate cost of the upgrade
California DOT		End of life	Storage for location that went to LED	Grid old 4X4 new 60 inch LED	Around a million for the large systems
South Carolina DOT	No				
Nebraska Dept. of Roads	No				
Colorado DOT					
West Virginia Division of Highways		Added an additional server			$2,500
NYSDOT	No				
PennDOT - Engineering District		Needed additional video display capabilities due to the additional cameras being deployed	Placed video processors for new video wall	The old layout was 18 - 19"" monitors and one rear projection 60"" display. The new is 18 - 50"" front access Video Cubes arranged 2x9	There were two upgrades, the first of which was just 10 - 50"" Video Cubes, and the second added four cubes on either side of the original 10. These costs combined where around $320,000
Palm Beach County Traffic Division		New location	Combined operational facility for FDOT and Palm Beach County. FDOT staff responsible for freeway operations and the County for the arterial street management	Old 800 square feet; new 4400 square feet (including server room)	$7,000,000
Florida DOT		Barco was terrible	Went to Plasma and LCD displays	Same size - 20 feet by 8 feet	$400,000 for video wall controller and monitors
Colorado Department of Transportation		Build new center	Rear projection cubes	20” televisions	$300,000
Sacramento County Department of Transportation		Lamps expensive and monitors starting to fail	Storage	Old:6””- 52"" projection cubes, 8 35"" color monitors. New: 12 - 42"" LCD flat screens	$165,000

Response / Organization	No	Yes, please specify main reason for upgrading	Yes, please provide information how you utilize space previously dedicated to projector(s)the TMC?	Yes, please describe briefly size/layout of old and new monitors	Yes, please specify approximate cost of the upgrade
Florida Department of Transportation	No				
FDOT District 4		Increase the size of the video wall	Display CCTV images, incident counts, telecommunication network status	Old: 9 cubes; new: 33 cubes	$1,200,000
Miami-Dade Public Works & Waste Management	No				
Minnesota Department of Transportation		Failure of CRT monitors	Wall was redesigned for flat screen monitors		$300,000
Caltrans		Requirement to improve operations	No projectors used due to limited space and low bulb life	Old: various TV sizes sitting on milk crates. New: 5h x 3 v grid using 5-32"" monitor panels and 10-46"" monitor panels; All panels NEC commercial grade type.	Estimate $200,000 plus labor
NJDOT	No				
City of Orlando	No				
Georgia DOT		Original equipment reached end of life	Scaffolding that held old projectors was removed	100"" projection screens. New are LED cubes	$400,000
Wisconsin Department of Transportation	No				
Michigan Department of Transportation	No				
Florida's Turnpike Enterprise		Time replacement of older video wall		3 cubes, 4ft x 4ft	

Response / Organization	No	Yes, please specify main reason for upgrading	Yes, please provide information how you utilize space previously dedicated to projector(s)the TMC?	Yes, please describe briefly size/layout of old and new monitors	Yes, please specify approximate cost of the upgrade
Texas Department of Transportation - Houston District					
Pasco County Traffic Operations	No				
Texas Department of Transportation		Replaced old projectors with two 65 inch plasma projectors	Two 65 inch plasma projectors	Two 65 inch plasma projectors	$10,000
TXDOT	No				
Delaware Department of Transportation		Maintenance cost and capabilities of old system	Same space just less depth		$300,000
Kansas City Scout		Old technology getting too expensive (bulbs)	Developed an entire technician workshop in place where all the rear projection TVs went.	Removed reprojection cubes, reinforced the wall, and installed new LCD TVs. Scout now has 16 55 inch LCDs and on the side 42 inch TV pods with 4 TVs hanging from the ceiling.	$80,000 with software integration and networking cost included
Oregon Department of Transportation		Aging monitors		Same as previous - 6 67"" cube monitors	$197,000
Montana DOT	No				
Mississippi Department of Transportation	No				
City of Glendale	No				
Town of Gilbert	No				
Boston Transportation Department		Barco bulbs were expensive		Old was 50" by 8 new 52" by 8 LED based	
Caltrans		Built new building	N/A	Old 2x3 New 3x4	$300,000
Southern TOC: Tucson, AZ	No				
Amey, Birmingham, UK	No				
Transport for NSW, Australia		Out of Date	Same space	DLP cubes and CRT replaced with full DLP	$ 1,000,000

Response / Organization	No	Yes, please specify main reason for upgrading	Yes, please provide information how you utilize space previously dedicated to projector(s)the TMC?	Yes, please describe briefly size/layout of old and new monitors	Yes, please specify approximate cost of the upgrade
NMDOT		Expanded viewing area to accommodate more feeds			
Manatee County	No	New TMC		Old was 2 flat screens New is 16 flat screens	Video wall was $40,000
Trafficware				Three re-fits of center	
Department of Transport and Main Roads					

2.3 Operational Issues

The following question is asked regarding operational issues:

1. Please select all applications for which your agency has functional operational strategies. Outline of available answers is shown in Figure 2.15.

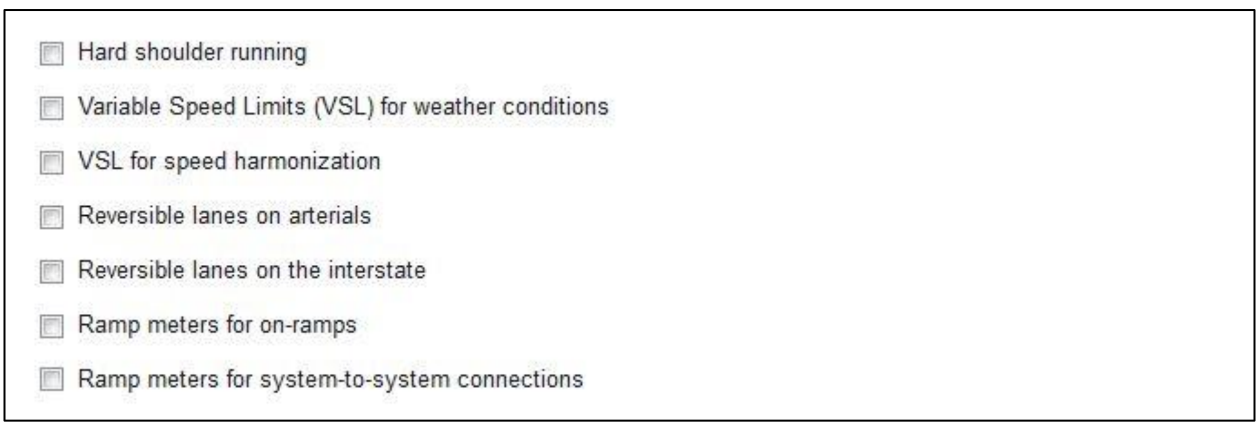

Hard shoulder running
Variable Speed Limits (VSL) for weather conditions
VSL for speed harmonization
Reversible lanes on arterials
Reversible lanes on the interstate
Ramp meters for on-ramps
Ramp meters for system-to-system connections

Figure 2.15 Operational Issues

Number of agencies which have particular functional operational strategy is shown in Figure 2.16. Results are summarized in the Table 2.14. Please note that the total number of agencies which responded to this question is 26.

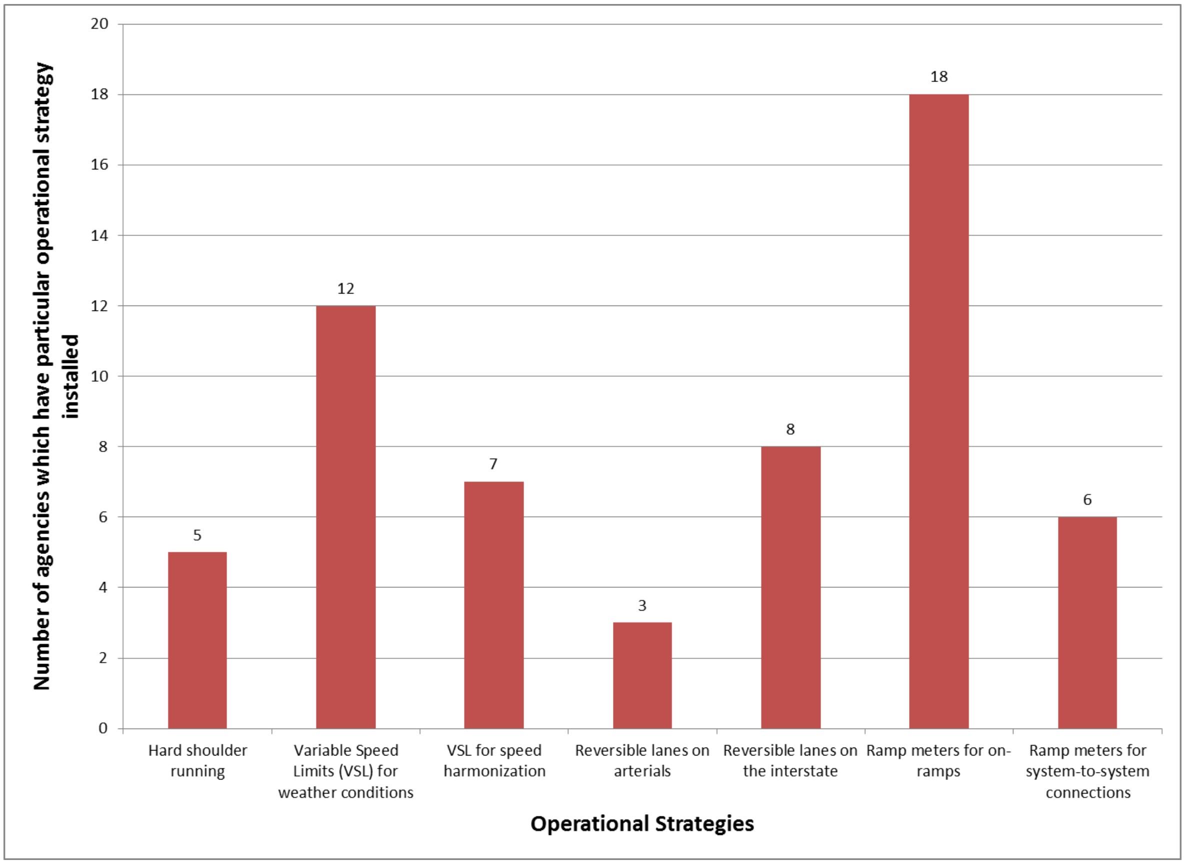


Figure 2.16 Agencies' Operational Strategies

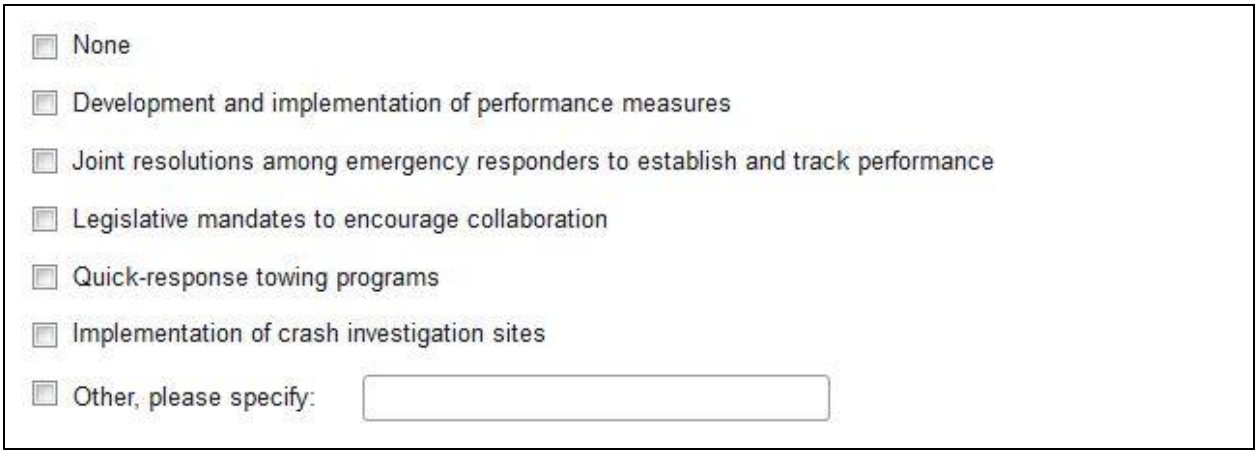
Table 2.14 Operational Strategies - Summary

Operational Strategy	Number of agencies which have particular operational strategy implemented
Hard shoulder running	5
Variable Speed Limits (VSL) for weather conditions	12
VSL for speed harmonization	7
Reversible lanes on arterials	3
Reversible lanes on the interstate	8
Ramp meters for on-ramps	18
Ramp meters for system-to-system connections	6

2.4 Incident Management

One question regarding incident management was part of the survey. Question is:

1. What strategies your agency implemented to successfully reduce incident clearance times? Outline of available answers is shown in Figure 2.17.



- None
- Development and implementation of performance measures
- Joint resolutions among emergency responders to establish and track performance
- Legislative mandates to encourage collaboration
- Quick-response towing programs
- Implementation of crash investigation sites
- Other, please specify:

Figure 2.17 Incident Management

In total, 46 agencies replied to this multi-select question. Responses are summarized in Figure 2.18 and Table 2.15.

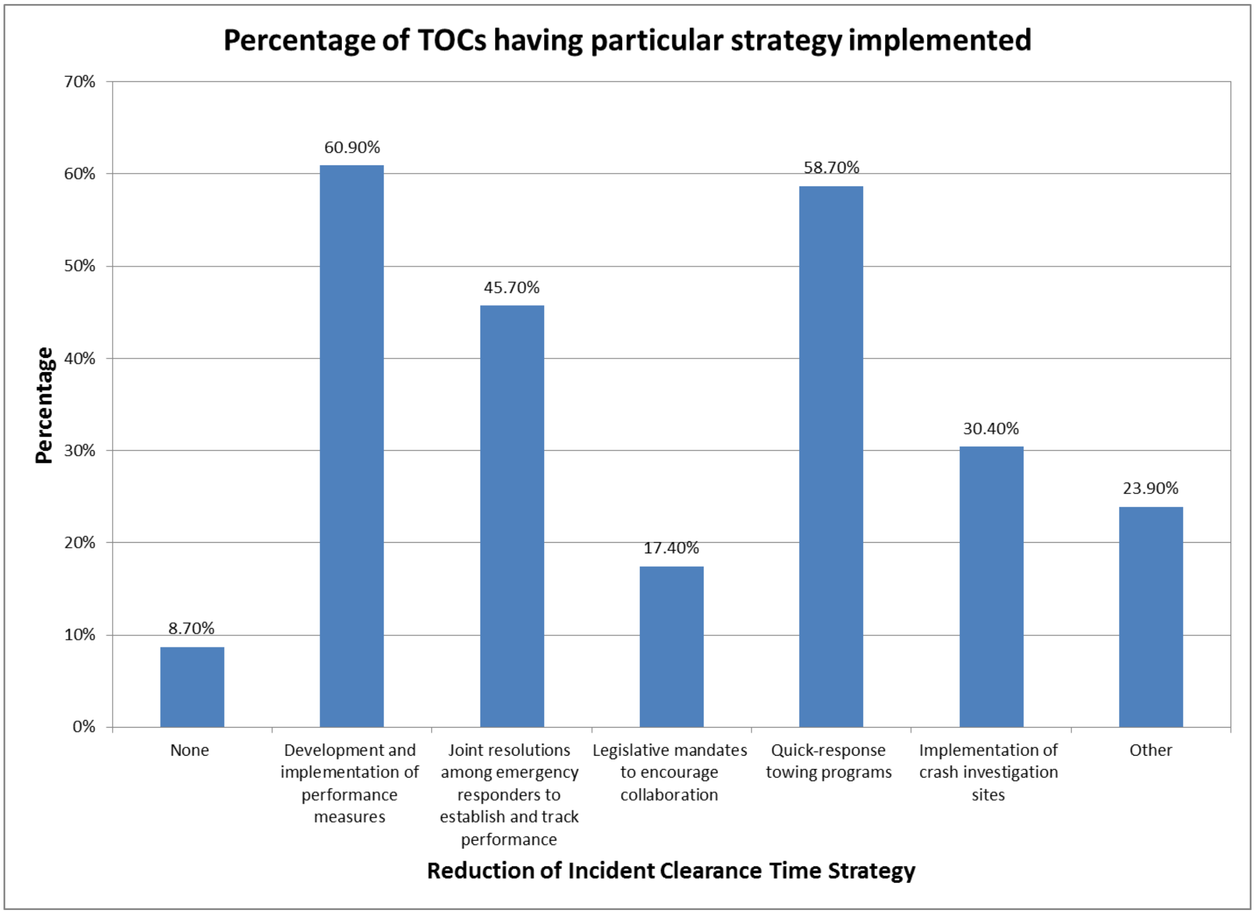


Figure 2.18 Reduction of Incident Clearance Times

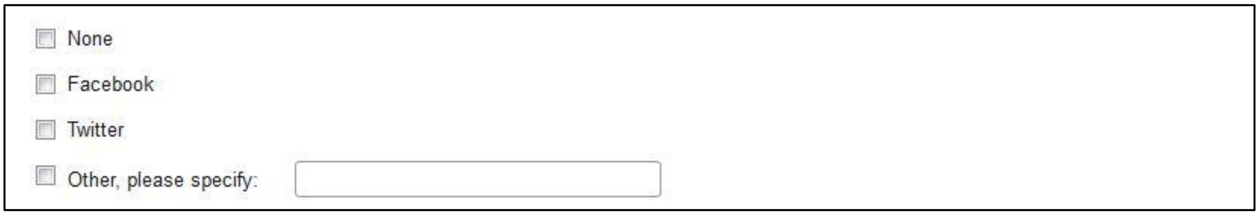
Table 2.15 Reduction of Incident Clearance Times - Summary

Strategy for reduction of incident clearance time	Number of responses	% of total answers
None	4	8.70%
Development and implementation of performance measures	28	60.90%
Joint resolutions among emergency responders to establish and track performance	21	45.70%
Legislative mandates to encourage collaboration	8	17.40%
Quick-response towing programs	27	58.70%
Implementation of crash investigation sites	14	30.40%
Other	11	23.90%

2.5 Travel Information System

Two questions regarding travel information systems were part of the survey. Questions are:

1. Which social media do you use to reach to the travelers? Outline of available answers is shown in Figure 2.19.



None

Facebook

Twitter

Other, please specify:

Figure 2.19 Travel Information System

Total number of agencies which repsonded to this question is 49. Summarized responses are shown in Figure 2.20 and Table 2.16.

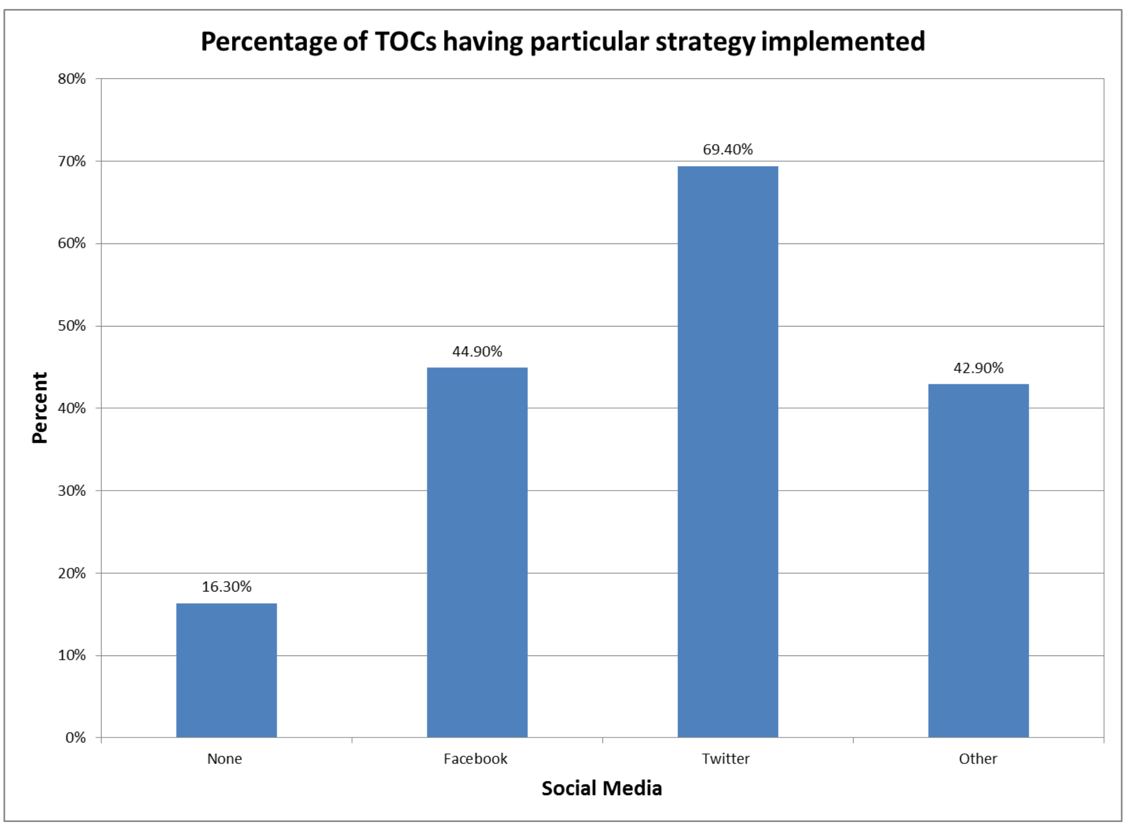


Figure 2.20 Social Media Utilization

Table 2.16 Social Media Utilization - Summary

Strategy	Number of agencies which have particular strategy implemented	% of total answers
None	8	16.30%
Facebook	22	44.90%
Twitter	34	69.40%
Other	21	42.90%

2. Your social media policy can be categorized as? Outline of the available answers is shown in Figure 2.21.

☐ Department-wide for all employees

☐ Related to publishing traveler information as a public service

☐ There is no social media policy

Figure 2.21 Travel Information System

In total, 49 agencies responded to this question. Responses are summarized and presented in Figure 2.22 and Table 2.17.

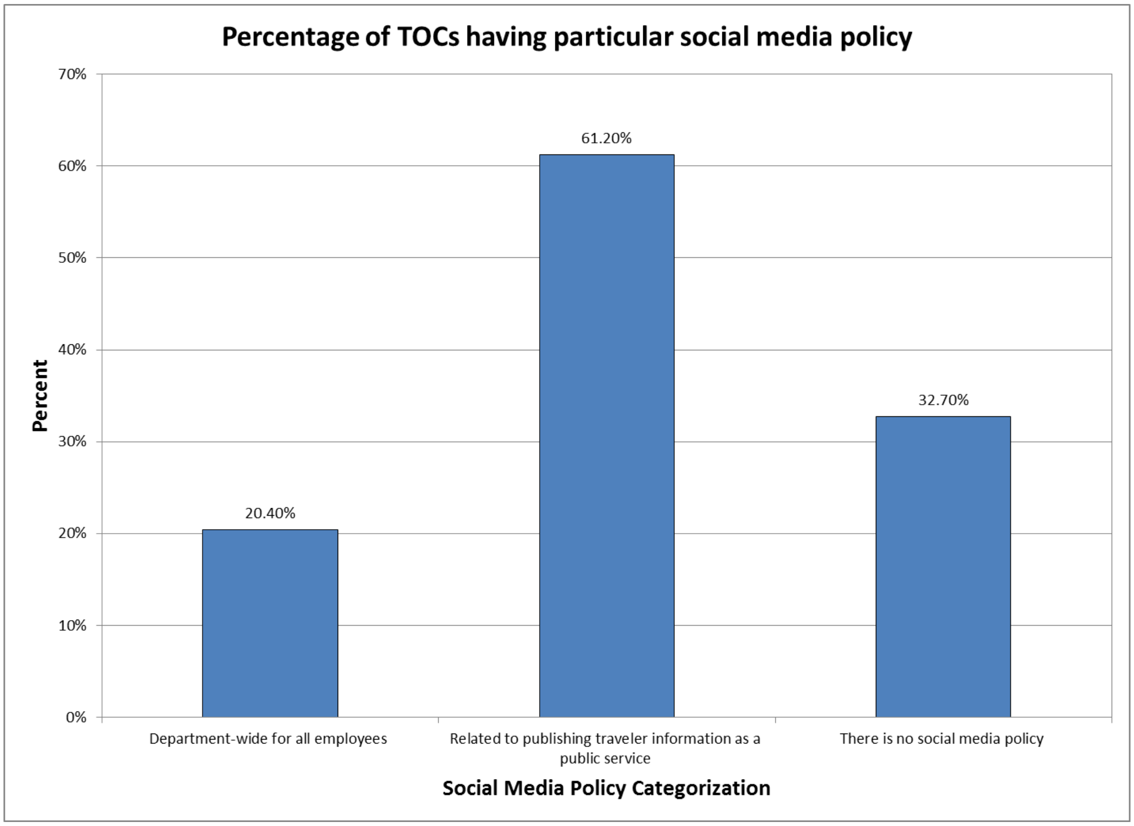


Figure 2.22 Social Media Policy Categorization

Table 2.17 Social Media Policy Categorization - Summary

Social media policy categorization	Number of responses	% of total responses
Department-wide for all employees	10	20.40%
Related to publishing traveler information as a public service	30	61.20%
There is no social media policy	16	32.70%

2.6 Institutional Collaboration

One question regarding institutional collaboration was part of the survey. The question is:

1. What external partnerships do you have (i.e., corridor coalitions, local/regional agencies, law enforcement)? Figure 2.23 shows the outline of this question in survey.

	External Agency	Purpose	Existing Connection Medium
1			-- Please Select --
2			-- Please Select --
3			-- Please Select --
4			-- Please Select --
5			-- Please Select --
6			-- Please Select --
7			-- Please Select --
8			-- Please Select --
9			-- Please Select --
10			-- Please Select --

Figure 2.23 Institutional Collaboration

Responses for this question were too robust to be summarized in a reasonable form. Reader is referred to Appendix B for individual responses.

2.7 Maintenance of the Existing System

One question regarding maintenance of the existing system in TOCs was part of the survey. The question is:

1. Do you track how long it takes to repair Advanced Traffic Management System (ATMS) equipment when it fails? Outline of available answers is shown in Figure 2.24.

No

Yes, job classification of a person responsible for tracking repair times is:

Figure 2.24 Maintenance of the Existing System

In total, 49 agencies responded to this question. Responses are summarized and shown in Figure 2.25 and Table 2.18.

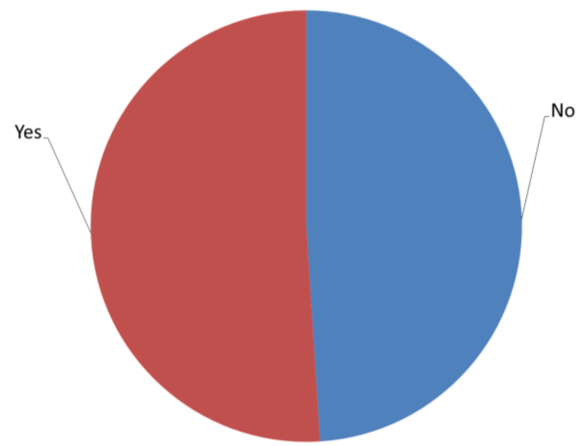


Figure 2.25 Tracking of ATMS Equipment Failure

Table 2.18 Tracking of ATMS Equipment Failure - Summary

Failure Track	Number of responses	Percent (%)
No	24	49.0
Yes	25	51.0
Total	49	100

2.8 Emergency Preparedness

One question regarding emergency preparedness was part of the survey. The question is:

1. Do you have minimum National Incident Management System (NIMS) training requirements for TMC staff? If yes, what level of training for each job classification? Figure 2.26 shows the outline of this question in survey.

	Level of Training Required
Management	-- Please Select --
Traffic Signal Engineer	-- Please Select --
Traffic Signal Analyst/Technician	-- Please Select --
ITS Engineer	-- Please Select --
Traffic Signal Maintenance Technician	-- Please Select --
Electronic Specialist	-- Please Select --
TMC Operators	-- Please Select --
Public Relations Coordinator	-- Please Select --

Figure 2.26 Emergency Preparedness

Agencies were able to choose between low, medium and high level of training required. Table 2.19 and Table 2.20 show summary of responses.

Table 2.19 NIMS Training Requirements for TMC Staff - Summary

Job Classification	Level of training required (counts)			Total (counts)
	Low	Medium	High	
Management	7	16	12	35
Traffic Signal Engineer	12	3	5	20
Traffic Signal Analyst/Technician	10	5	4	19
ITS Engineer	9	5	9	23
Traffic Signal Maintenance Technician	12	6	1	19
Electronic Specialist	11	6	1	18
TMC Operators	12	14	8	34
Public Relations Coordinator	7	10	2	19

Table 2.20 Training Requirements for TMC Staff – Percentage

Job Classification	Level of training required (%)			Total (%)
	Low	Medium	High	
Management	20	45.7	34.3	100
Traffic Signal Engineer	60	15	25	100
Traffic Signal Analyst/Technician	52.6	26.3	21.1	100
ITS Engineer	39.1	21.7	39.1	100
Traffic Signal Maintenance Technician	63.2	31.6	5.3	100
Electronic Specialist	61.1	33.3	5.6	100
TMC Operators	35.3	41.2	23.5	100
Public Relations Coordinator	36.8	52.6	10.5	100

2.9 Inclement Weather Operations

Two questions regarding inclement weather operations were part of the survey. The questions are:

1. Select all applications below for which you use weather or road condition sensors (such as Road Weather Information System - RWIS). For each application please specify whether it is automatically (or manually) triggered by inputs of road and condition sensors. Figure 2.27 shows the outline of this question in survey.

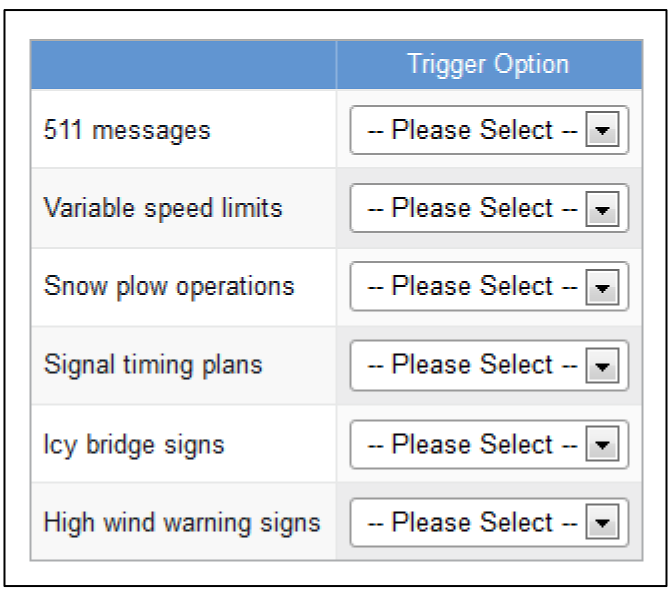


Figure 2.27 Weather/Road Conditions Sensors

In Table 2.21 and Table 2.22 summarized are responses from all the agencies which replied to the survey.

Table 2.21 Usage of Weather/Road Conditions Sensors – Summary

Applications	Trigger Option (counts)		Total (counts)
	Automatically	Manually	
511 messages	10	16	26
Variable speed limits	6	5	11
Snow plow operations	4	16	20
Signal timing plans	8	9	17
Icy bridge signs	3	8	11
High wind warning signs	3	17	20

Table 2.22 Percentage of Weather/Road Conditions Sensors Usage

Applications	Trigger Option (%)		Total (%)
	Automatically	Manually	
511 messages	38.5	61.5	100
Variable speed limits	54.5	45.5	100
Snow plow operations	20	80	100
Signal timing plans	47.1	52.9	100
Icy bridge signs	27.3	72.7	100
High wind warning signs	15	85	100

2. Which of the following sources of weather information do you use to prepare for a weather event? Outline of this question is shown in Figure 2.28.

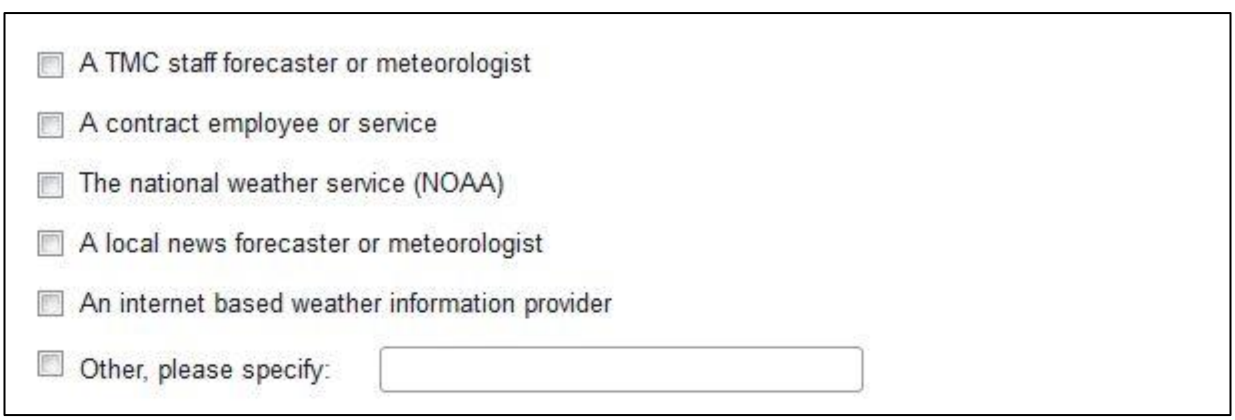

A TMC staff forecaster or meteorologist
A contract employee or service
The national weather service (NOAA)
A local news forecaster or meteorologist
An internet based weather information provider
Other, please specify:

Figure 2.28 Inclement Weather Operations

In total, 45 agencies responded to this question. Responses are summarized and presented in Figure 2.29 and Table 2.23.

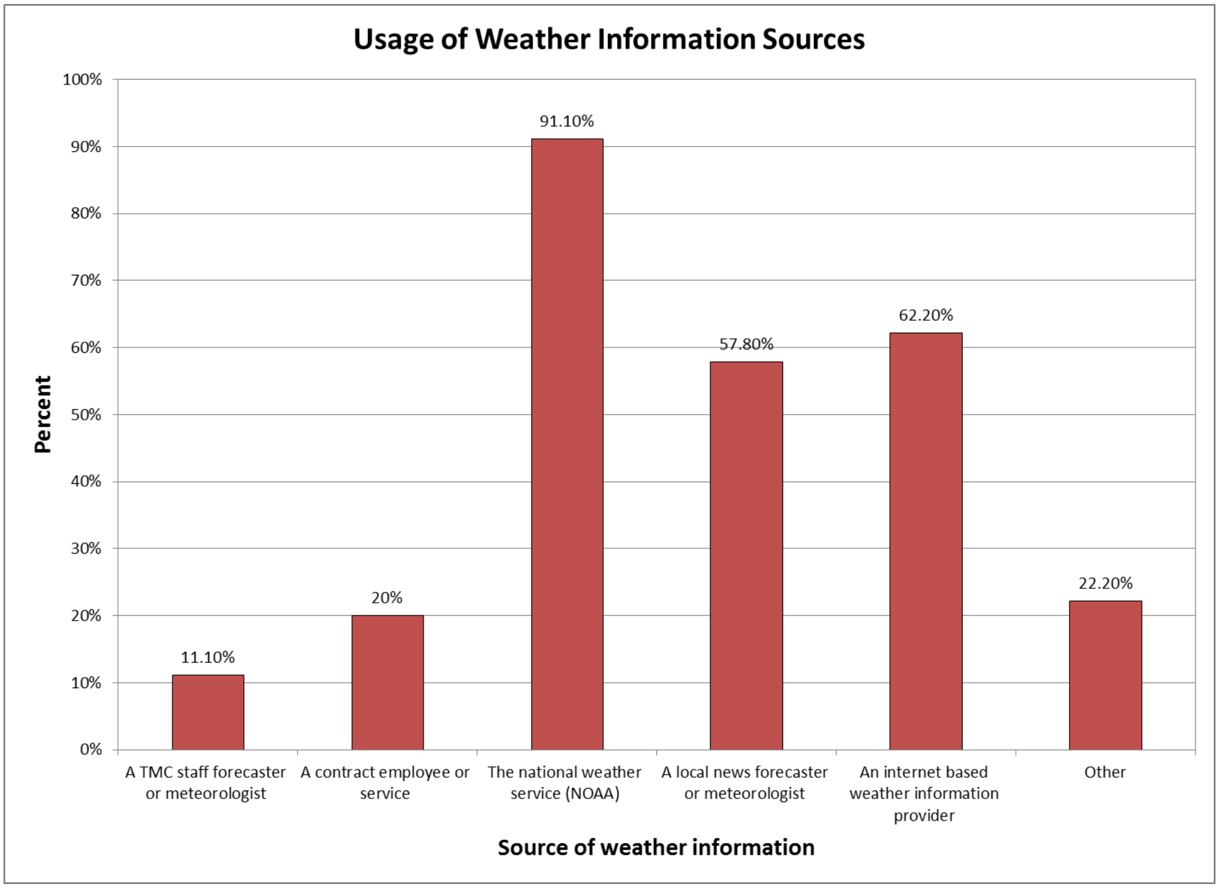


Figure 2.29 Weather Information Sources

Table 2.23 Weather Information System - Summary

Source of weather information	Number of agencies using particular source	Out of Total (%)
A TMC staff forecaster or meteorologist	5	11.10%
A contract employee or service	9	20%
The national weather service (NOAA)	41	91.10%
A local news forecaster or meteorologist	26	57.80%
An internet based weather information provider	28	62.20%
Other	10	22.20%

2.10 TOC policies

Five questions regarding TOC policies were part of the survey. The questions are:

1. What performance measures are used/reported by your TMC?

Table 2.24 contains summary of all the responses provided by transportation agencies/TOCs which participated in the survey.

Table 2.24 Reported Performance Measures

Organization	Performance measures used/reported by TMC
Virginia DOT - Operations and Security Division	Incident response clearance (minutes), incidents (accidents and fatalities), incident response time for Safety Service Patrol (minutes), service provided by Safety Service Patrol - number of responses and service provided
Lake County Division of Transportation	Number of users signed up for email service, smart phone apps Equipment online & maintained, number of incidents, number of emails sent out
Rhode Island DOT TMC	Travel Time Index, Roadway/Incident Clearance Times, Average Travel Time, 95%ile Travel Time, Planning Time Index, Buffer Index, Crash Rate, ITS Device Percent Uptime, Weekly Speed Profiles
Colorado DOT TMC	N/A
Ada County Highway District	Incident duration, number of freeway and arterial incidents, travel time, real-time freeway flow speeds
Louisiana DOTD	Incident blockage/clearance times Number and type of ITS devices used for an incident Number and type of services performed by Motorist Assistance Patrols (MAP)
Ohio DOT	Average hourly speed (monthly) vs, posted speed limit.
TDOT Region 3	Response/Clearance/Travel Times
Minnesota DOT	N/A
Idaho Transportation Department	Elapsed time from call to foremen to arrival at scene of incident
California DOT	Incident clearance times, number incidents managed
South Carolina DOT	N/A
Nebraska Dept. of Roads	Incident duration, DMS activations
Colorado DOT	N/A
West Virginia Division of Highways	Numerous performance measures
NYSDOT	Monthly reports prepared by HVTMC consultant staff
PennDOT - Engineering District	Number of incidents, Incident Times, ITS Uptime/Downtime
Palm Beach County Traffic Division	Palm Beach County is responsible for maintaining and managing traffic signals and operations for all traffic signals on State, County and City roads. Signal system, ATMS.now, is utilized to collecting operational alarms and performance of the TMC staff in responding to the alarms,

Organization	Performance measures used/reported by TMC
	signal timing changes, etc., is documented and reviewed frequently.
Florida DOT	Incident Response, clearance and recovery times. Signal up time and corridor travel time performance. Road Ranger Service Patrol assists.
Colorado Department of Transportation	Safety and mobility as relate to investment categories
Sacramento County Department of Transportation	Arterial performance (travel time & delay studies), crash rates, signal Timing Service Requests/Work Orders
Florida Department of Transportation	Please refer to www.sunguide.org for PM reports
FDOT District 4	Please see weekly, monthly, quarterly, and annual reports at: www.smartsunguide.com
Miami-Dade Public Works & Waste Management	N/A
Minnesota Department of Transportation	N/A
Caltrans	Our TMC creates logs of HAR and CMS usage and provides monthly logs to HQ
NJDOT	incident duration, IMRT statistics, SSP statistics
City of Orlando	None
Georgia DOT	Average incident response time, average incident clearance time, travel time on freeway corridors, average speeds on freeway corridors, number of 511 calls, number of hits to website, number of assists by Incident Management Unit, % of 511 calls transferred to ""live"" operator, average 511 call length, transfers of 511 calls to other agencies
Wisconsin Department of Transportation	N/A
Michigan Department of Transportation	Total number of Communications Number of Unplanned Incidents, incidents occurring in Work Zones, system availability, % Traffic Impact Types by Region, Incidents by Freeway Construction Projects per Region
Florida's Turnpike Enterprise	Notification Duration; Verification Duration; Response Duration; Open Roads Duration; Departure Duration, Roadway Clearance Duration, Incident Clearance Duration
Texas Department of Transportation - Houston District	Clearance Time, Travel Times
Pasco County Traffic Operations	N/A
Texas Department of Transportation	Annual report created by the FHWA
TXDOT	None
Delaware Department of Transportation	Just started providing roadway reliability
Kansas City Scout	Too many to list. See www.kcscout.net, or MoDOT tracker @ www.modot.org. We produce an executive set of performance measures and an operational set which quite larger to refine operations
Oregon Department of Transportation	N/A

Organization	Performance measures used/reported by TMC
Montana DOT	N/A
Mississippi Department of Transportation	Monthly alerts, website usage, network bandwidth, top 10 intersections with the most crashes
City of Glendale	N/A
Town of Gilbert	N/A
Boston Transportation Department	Percent of signals under computer control, number of CCTV cameras operational
Caltrans	Monthly major events, fatalities, unplanned events, weather events, amber alerts, and planned maintenance stats. Other data is recorded and may be measured by others
CALTRANS	Monthly Major Events Statistics, fatalities report, weather events, unplanned roadway events, amber alerts and planned Maintenance Statistics.
Southern TOC: Tucson, AZ	Incident Locations/Severity
Amey, Birmingham, UK	Setting of various systems and reporting of faults. Incident detection and clearance of incidents
Transport for NSW, Australia	Incident clearance time, route travel time
NMDOT	Incident Response and Clearance (associated with Motorist Assistance Patrol Units). Establishment of annual Goals and Objectives - Identifies and prioritizes needs that are addressed as near-term, mid-term, and long-term. Heavily focused on infrastructure and resource development (communications, devices, TMC improvements [hardware and software], training and agreements)
Manatee County	Number of incidents detected, number of reports/assistance to signal timing/maintenance activities, IT support requests, number of requests for information
Trafficware	Number of alarms, time to correct, response time
Department of Transport and Main Roads	Incident response times on the network call taking

2. Which of the following methods do you use to report performance measures? Outline of the available answers is shown in Figure 2.30.


- [ ] Internally, informal reports
- [ ] Internally, formal reports
- [ ] Externally, informal reporting on a website or dashboard
- [ ] Externally, formal published reports
- [ ] Other

Figure 2.30 TOC Policies

Responses are summarized and presented in Figure 2.31 and Table 2.25.

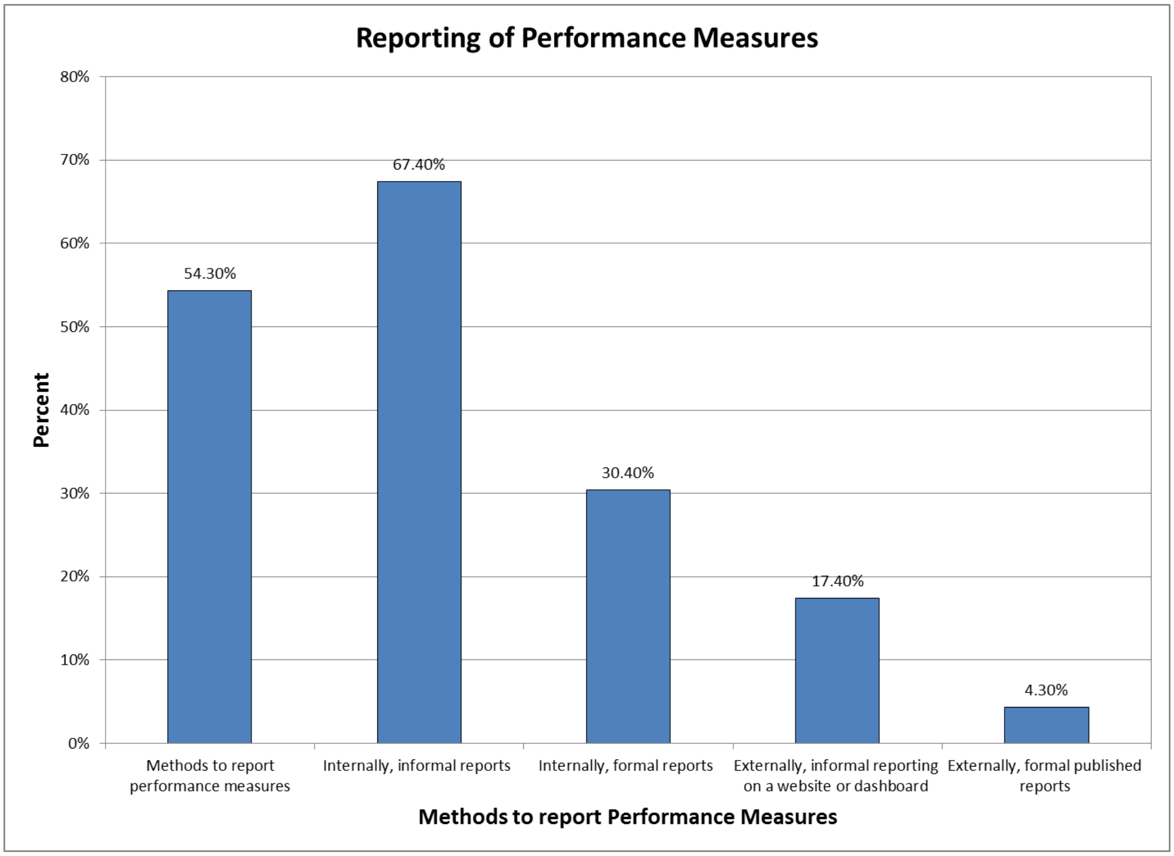


Figure 2.31 Performance Measures Reporting Methods

Table 2.25 Methods to Report Performance Measures - Summary

Methods to Report Performance Measures	Number of Agencies using Particular Method	Out of Total (%)
Internally, informal reports	25	54.30%
Internally, formal reports	31	67.40%
Externally, informal reporting on a website or dashboard	14	30.40%
Externally, formal published reports	8	17.40%
Other	2	4.30%

3. How often do you update your functional operations manual? Outline of available answers is shown in Figure 2.32.

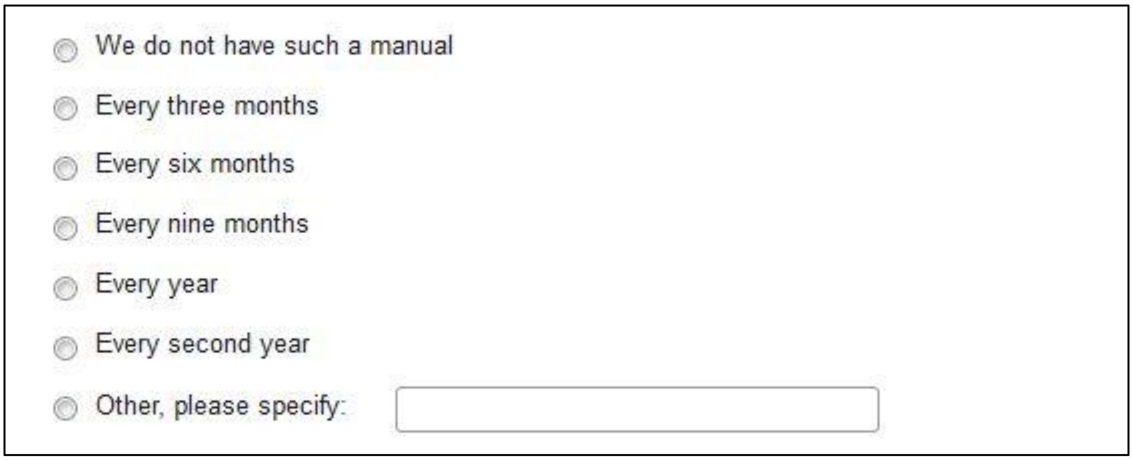

We do not have such a manual
Every three months
Every six months
Every nine months
Every year
Every second year
Other, please specify:

Figure 2.32 TOC Policies

In, total 47 agencies responded to this question. Responses are summarized and presented in Figure 2.33 and Table 2.26.

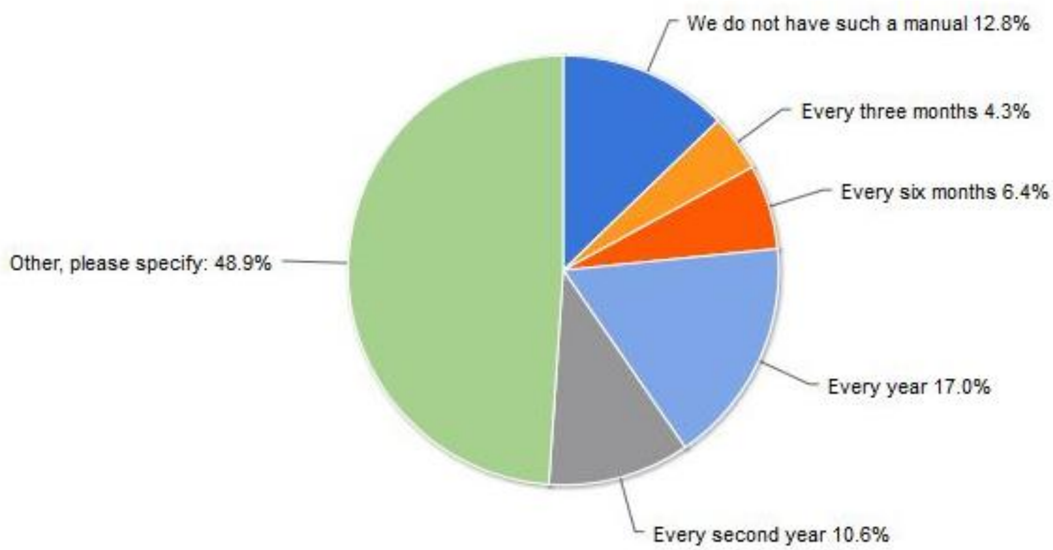


Figure 2.33 Operations Manual Update

Table 2.26 Operations Manual Update - Summary

Functional Operations Manual	Number of agencies updating the manual in particular time frame	Percentage (%)
We do not have such a manual	6	12.80%
Every three months	2	4.30%
Every six months	3	6.40%
Every nine months	0	0%
Every year	8	17%
Every second year	5	10.60%
Other	23	48.90%

4. Who is in charge of updating your operations manual? Outline of the available answers is shown in Figure 2.34.

Figure 2.34 TOC Policies

In total, 47 agencies responded to this multi-select question. Responses are summarized and presented in Figure 2.35 and Table 2.27.

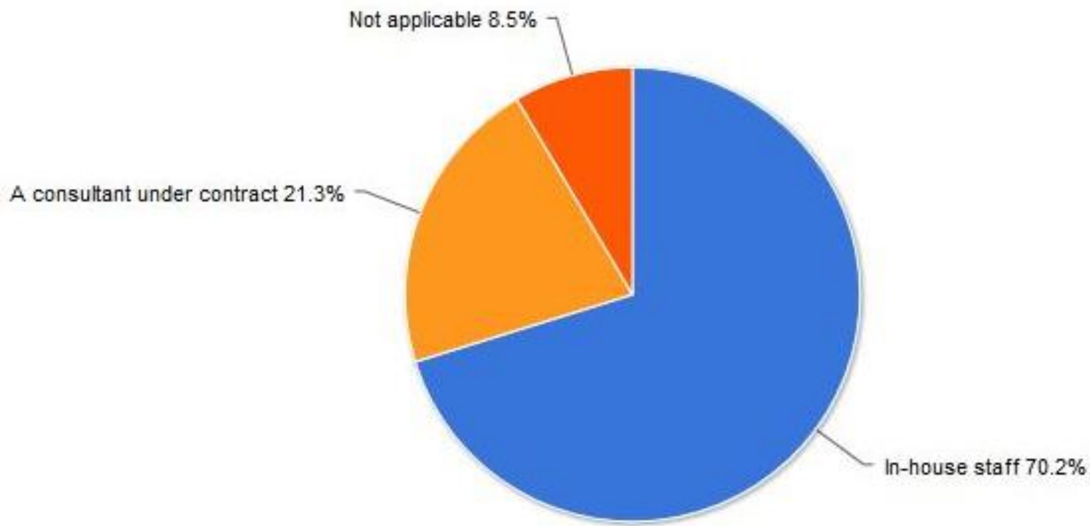


Figure 2.35 In Charges of Operations Manual Update

Table 2.27 In Charges of Operations Manual Update – Summary

Person/Institution in charge of operations manual update	Number of agencies having particular staff in charge	Percentage (%)
In-house staff	33	70.20%
A consultant under contract	10	21.30%
Not applicable	4	8.50%

5. Which of the following options is the best to describe current status of preparing for the Real-Time System Management Information Program under Section 1201 of the Safe, Accountable, Flexible and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) at your agency? Outline of available answers is shown in Figure 2.36.

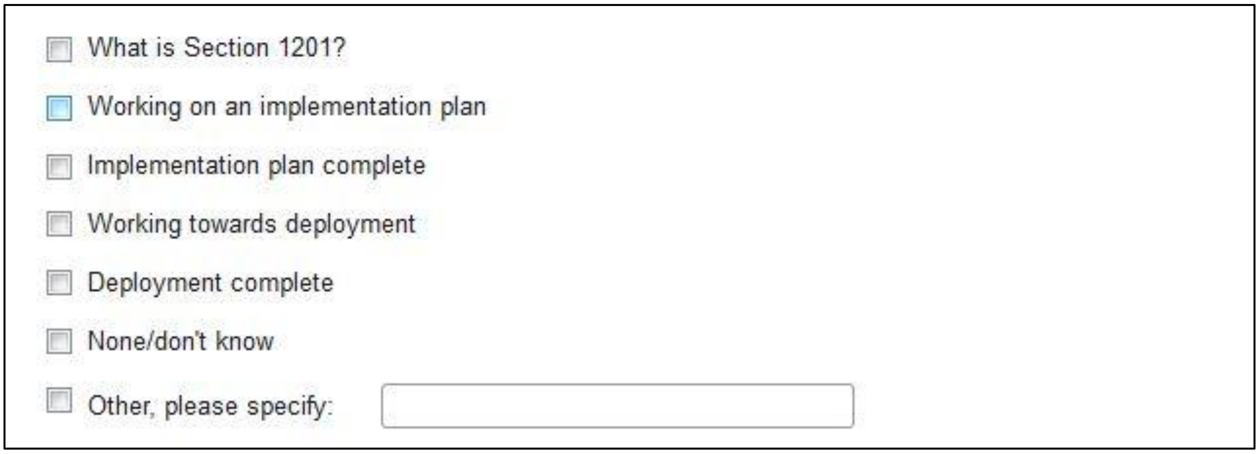


Figure 2.36 TOC Policies

In total, 46 agencies responded to this multi-select question. Responses are summarized and presented in Figure 2.37 and Table 2.28.

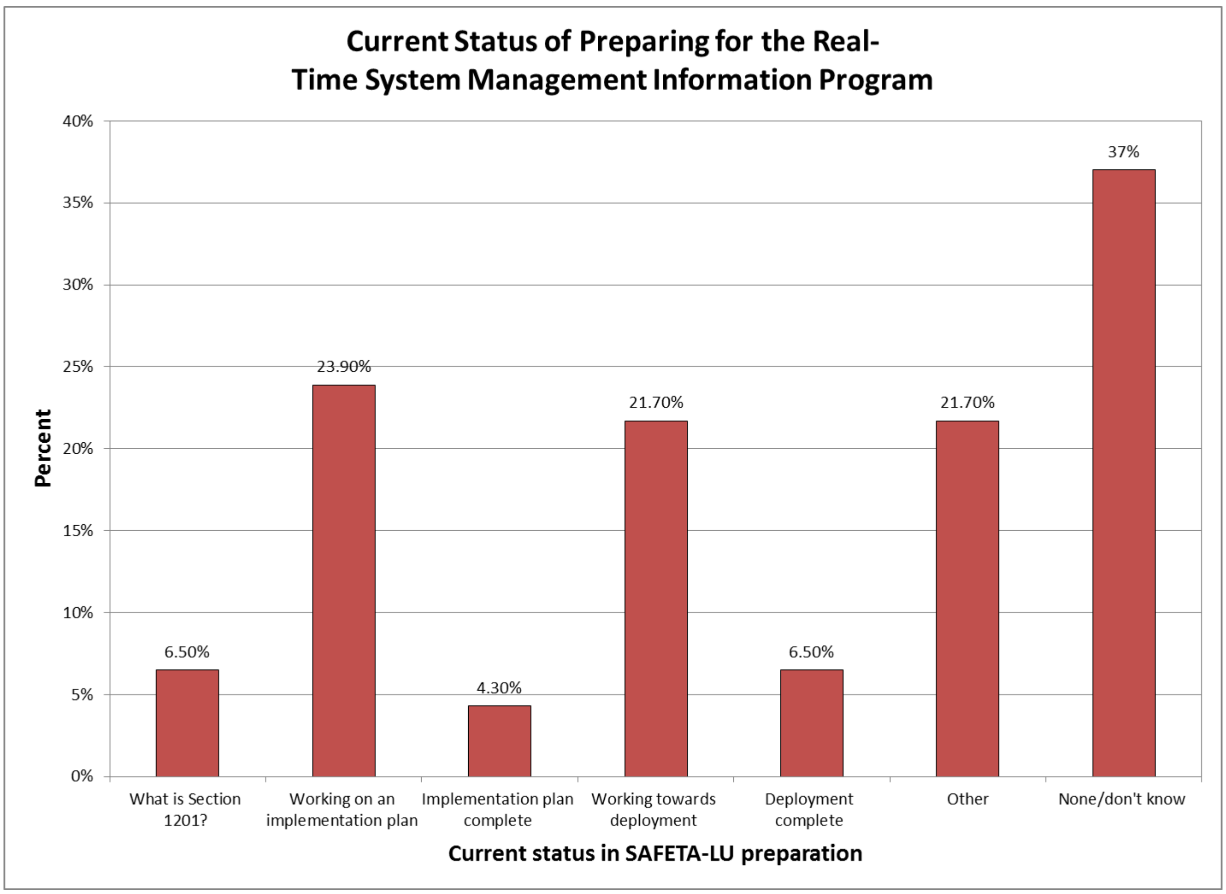


Figure 2.37 SAFETA-LU Preparedness

Table 2.28 SAFETA-LU Preparedness - Summary

Current status of SAFETA-LU preparedness	Number of agencies being in particular stage	Out of total (%)
What is Section 1201?	3	6.50%
Working on an implementation plan	11	23.90%
Implementation plan complete	2	4.30%
Working towards deployment	10	21.70%
Deployment complete	3	6.50%
Other	10	21.70%
None/don't know	17	37%

2.11 Other

Additional two questions asked for any additional documents, comments or information which could be useful in conducting of this survey. The questions are:

1. Please upload and briefly describe any additional documents/files that you may find relevant for the purpose of this survey.

2. Do you have any other comments/information that you would like to share?

All additional documents uploaded and comments/information posted, can be found in Appendix C.

3.0 SUMMARY OF EASTERN STATES

3.1 Overview

This chapter summarizes impressions from field visits to TOCs in the eastern (with exception of Minnesota) states of US. Field visits were conducted in Minneapolis (MN), Pittsburgh (PA), Columbus (OH), and Fairfax (VA). At the end of each subchapter (covering a single TOC) relevant highlights from the corresponding visit are presented.

3.2 Minnesota (MN) DOT

Focus of the MN DOT TMC is on freeway operations, covering most of the state freeways (5300 lane-miles). Road maintenance and state police (Department of Public Safety) are also dispatched from the floor of the control room by their own staff. There is a notion that more stuff should be accomplished with fewer resources. This leads to an extreme goal of trying to accomplish everything with nothing. The MN DOT has a system manager who has a strong background in systems engineering and extensive knowledge of ITS technologies and devices which are deployed by the TMC system (both in the control room, IT room, and field).

3.2.1 High Occupancy Toll Lanes

HOT lane management and maintenance is performed by private contractors. HOT operations are seen only as a traffic management tool and revenue generation is not of primary importance.

3.2.2 Variable Speed Limits

VSL & other lane control signs overhead on the freeway are controlled by the operators. VSL is advisory only. MN DOT utilizes hard-shoulder running – on about 250 miles shoulders are run by buses during congested intervals (<30-35 mph). Mainly outside shoulders are used for this purpose. MN DOT has a policy on minimum shoulder widths: 11-ft - 11.5 ft lanes on outside shoulders and 10-ft lanes on inside shoulders. MN DOT personnel do not see that clear zones are problem.

3.2.3 ATMS Software

Software for TMC operations is developed in-house. MN DOT has an archive of 15 years of traffic data - 5 minute data until 1998 and 30-seconds data after 1998. The MN DOT archiving software consists of a couple of JAVA-based software tools which can be used to plot and extract data. It takes a lot of effort & time to run these tools. MN DOT is considering Portable Emissions Measurement Systems (PEMS) software for future installation.

3.2.4 Freeway Incident Response Safety Team (FIRST)

MN DOT freeway incident response team covers only freeways. DOT employees and trucks are used for the incident response teams (utilizing only blue and amber lights). Their overall operating budget is US$ 1.5 million per year and there are no sponsors. MN DOT opinion is that financial benefits obtained from sponsors are not worth public recognition that DOT gives up if a name of the sponsor is emphasized. MN DOT wants to get recognized for good service that is being done. There are usually 8-9 routes which are patrolled in the morning and 10-11 during PM peaks. In recent years the MN DOT was able to increase number of routes. There is usually one truck/route that operates on weekends. MN DOT has not had significant issues with removing vehicles from lanes. MN DOT staff emphasizes good collaboration with state troopers.

3.2.5 Traffic Signals

There are around 3000 signals statewide with 13-14 hundred under MN DOT jurisdiction out of which around 700 signals are in the metro area. Under TMC MN DOT communicates with 670 signals of which 150 are under internet or fiber. Two central traffic signal systems are used: I2 and TACTICS. MN DOT has lost a lot of functionalities when switching to TACTICS (controllers are not compatible). 500 signals are on dial-up service. The signals are numbered in such a way that even numbers represent Eagle controllers while odd numbers represent Econolite. It is important for MN DOT to keep at least two traffic controller manufacturers to compete for new requisitions - it reduces costs of purchasing new signals. MN DOT is not interested in adaptive control but they have a consistent signal retiming plan that retimes signals every 3-5 years.

3.2.6 Radio Station

The media partner is KBM-radio station which is owned by a local public-school district. One-minute traffic updates are broadcasted every 10 minutes. During major incidents and events the coverage is continuous. MN DOT pays around US$ 200,000 per year for media service. KBM media partner broadcasts from the floor of the control room. Significant advantage of this arrangement is that a KBM radio operator can closely interact with TMC operators. The traffic updates are sometimes (on a per-needed basis) provided every 5 minutes. MN DOT does not operate Highway Advisory Radio (HAR).

3.2.7 Maintenance

MN DOT maintenance is mainly responsible for maintenance of signs, road surface, vegetation control, and snow removal. Four out of 18 maintenance stations in the metro area work overnight. This number increases to 8 overnight truck stations during winter months. During winter the road maintenance relies heavily on road surface temperatures for snow plan.MN DOT uses sodium chloride as the main deicing material. Envirotech anti-icing system is mostly used for main bridges. MN DOT currently operates 4 tow plow trucks with plans to add 10 more trucks in future years. Echelon plowing is often deployed to increase efficiency of the snow removal in spite of the fact that this mode shuts down the road. MN DOT does not hesitate to send tow plow vehicles alone - they have good lights & laser beams and get respect from the motorists in spite of their width (26 ft wide). They are usually operated at speeds of 25-40 mph.

3.2.8 Weather Information

MN DOT is contracting private contractor to provide weather reports every 6 hours. MN DOT subscribes to several weather sources including RWIS and University of North Dakota - which are main sources for weather information system. In addition MN DOT uses TELVENT forecasts for weather and impact that weather will have on roads & traffic. During winter this helps MN DOT to prepare maintenance shifts a day ahead of time. MN DOT operates 237 plow trucks in metropolitan area. Truck stations do not have access to ATMs data but dispatcher calls are recorded and entered into a work-order system. MN DOT is considering adoption of the Wyoming citizen-reporting and similar programs.

3.2.9 511 Traveler Information System

MN DOT uses a 511 Traveler Information System developed by Castle Rock which reports maintenance and construction activities and incidents (CAD system). The system can also be used as an archive database for CAD. Sometimes there is latency and CAD information is updated every 5 minutes (sometimes every 15min). Construction and maintenance activities are not updated in real time but are posted 3 days in advance. Project construction activities are displayed on Variable Message Signs (VMS). Websites with Closed Circuit Television (CCTV) video images are refreshed every 5 seconds. 511 phone system is used but according to MN DOT represents an outdated product and should be soon replaced with mobile phone apps and similar.

3.2.10 Asset Management

MN DOT provides back-up batteries for ATMs devices and fiber hubs. They also utilize recording system / software to note that a camera (or another device) is not working. Their asset management system is old, inflexible and they want to replace it. They are also looking to develop a new strategic maintenance plan. Their Highway Systems Operations Plan has two components: operational needs are assessed every 4 years, and capital investment is planned with 20-year horizon.

3.2.11 Ramp-metering

MN DOT policy for system-to-system ramp metering is to hold maximum to 4 minutes on ramps or 2 minutes on each facility (system-to-system). The goal is to balance between queue management versus mainline management. Queue detectors are used to measure number of cars going in and detecting the end of queue. MN DOT is currently running a volume-based (capacity) ramp metering that adjusts metering rate every 30 seconds with available capacity.

MN DOT wants to switch to a density-based algorithm (threshold should be 43 veh/ln/hour) with adjustment frequency of 6 seconds.

3.2.12 Video Wall and Control Room

MN DOT TMC has a large video wall, but most screens are divided in quadrants and labeled for specific purposes. Video wall is being upgraded to Liquid Crystal Display (LCD) flat panel displays. Work stations have moveable work surfaces and individual climate control. Control of video feeds and cameras is conducted by specially designed keyboards with joysticks. Video feeds are not recorded but they can be buffered for 4 days. Cameras, which are usually available for media can be "unpublished" so that they are not available for media. Natural light onto the operations floor and acoustic ceilings were important design considerations for the control room. The control room has a separate area for traffic signals (a “signal desk”).

3.2.13 Highlights

After conducting field visit to Minnesota DOT TMC, the following observations are marked as the most important to UDOT professionals:

- MN DOT thinks financial benefits obtained from sponsors are not worth name trade off
- It is important that at least two traffic controller manufacturers compete (for pricing)
- MN DOT is considering adoption of the Wyoming weather citizen-reporting
- 511 phone systems, according to MN DOT, represent an outdated product and should be soon replaced with mobile phone applications and similar tools
- Video wall is being upgraded to LCD flat panel displays, work stations have moveable work surfaces and individual climate control, control of video feeds and cameras is conducted by specially designed keyboards with joysticks, control room uses natural light and acoustic ceilings

3.3 Pennsylvania (PA) DOT

The TMC manager, who has a system engineering background and is familiar with ITS technologies and devices, recommended UDOT to attend the “Operations Academy for Senior

Management" at the University of Maryland. PA DOT TMC is a smaller regional TMC which covers 18 counties and coordinates with 3 other districts. A small video wall uses rear projection system. To reduce costs of replacing projector lamps TMC manager suggested practice of buying replacement light bulbs without replacing the entire lamp.

3.3.1 Reversible Lanes and Variable Speed Limits

PA DOT utilizes reversible lanes (mostly as access to event venues) which serve as High Occupancy Vehicle (HOV) lanes in AM and PM peak periods and general purpose lanes (in PM peak dominant traffic direction) after 7 PM until next morning. However, there is a notion that capacity of reversible lanes is not balanced and fully utilized. Variable speed limits are not used currently but there is a plan for their deployment in future. Major concerns are restrictions on heavy vehicles during peak hours. Heavy vehicles impose a significant problem due to their inability to move quickly on hilly terrain.

3.3.2 Winter Maintenance

PA DOT has a fully-automated weather responsive (triggering) system for key snow routes throughout the state. There are several belt routes which are defined along I-90 and another belt around I-80. In average there is 12ft of snow per year but this number reaches 20ft during some years. Weather information from field arrives to TMC. The system represents a fully automated weather responsive system which provides warnings in the early stages of storm. Weather information is coming from multiple information sources including Road Weather Information Systems, commercial AccuWeather package, National Weather Service, etc. The most difficult weather information to gather is local storms which are created locally due to lake effects and similar and which cannot be caught by radars. PA DOT puts a lot of emphasis on anti-icing (as opposed to de-icing) and it has an extensive network of bridge anti-icing systems which are connected to the TMC. Once icing occurs PA DOT is mostly using brine as a de-icing material due to its low costs. PA DOT is deploying the first flood-warning system in PA.

3.3.3 511 Traveler Information System

PA DOT uses their 511 Traveler Information System to report road conditions, which are manually updated. Road condition information is gathered from county maintenance employees under Pennsylvania Department of Transportation (PENNDOT); some of them are temporary employees during winters). The data comes from 67 counties in PA, some of which are combined for the purpose of reporting road conditions. Maintenance sections (shed staff) report road conditions every hour or on a per-needed bases and the road weather conditions are divided into six major categories:

1. Clear & dry (they do not have report if the temperature is above 40°F)
2. Clear & wet (report every hour (foreman for each section reports through radio system and/or Blackberries)
3. Snow & slush covered with wheel tracks exposed
4. Snow & slush covered
5. Icy
6. Impassable

Maintenance shifts are rearranged during winter operations. From Nov 1st to Apr 15th there is a radio room operator who passes information on weather conditions. Media partner broadcasts from a room adjacent to the control room.

3.3.4 ATMS Platform

PA DOT website is developed by a consultant. There is 511 phone system and web site. According to PA DOT future of 511phone systems is questionable. It is an obsolete technology that will soon be replaced by mobile phone applications etc. PA DOT is currently working on sharing video feeds from its cameras either as full stream or video clips which are updated every 10 seconds. It is expected that once the ATMS is integrated with in-vehicle Global Positioning Systems (GPSs) from individual vehicles there will be abundance of information to be shared with travelling public and 511 phone system and dynamic message signs will become obsolete.

3.3.5 Maintenance of ITS Devices

Maintenance of ITS field devices is contracted out and this is the case for all districts of the PA DOT. DOT itself performs only minor ITS maintenance. PA DOT has a system in place to monitor performance of the contractors – with 96% uptime target. Superintendents report 40 hours a week and they are located at TMC which significantly reduces their response time. On the other hand, such an arrangement frees DOT from a need to purchase and maintain its own equipment (e. g. bucket truck). The same maintenance contractors are employed since 2005. PA DOT has internally developed asset management tracking system (MS Access database) which is used to record costs of the maintenance, duration of repairs, etc. Wire theft is not a significant issue but it happened few times in the past. It is very important to know which crews are currently on the road performing maintenance. For this reason PA DOT has a notification system which shows who is out there on the road all of the time. Also, there are written procedures that maintenance crews need to follow when going out to the field. These procedures increase level of accountability for maintenance crew's actions.

3.3.6 Incident Management

As part of their Incident Command System (ICS) PA DOT has 15-20 people in their district that are certified to ICS level 300 and 4-5 people with higher certification levels (e.g. 400). The area command sits at the central office and there is an incident commander in every district. Five people from the TMC district can currently take a role of an incident commander and TMC manager is one of those five. Role of an incident commander is to be aware of what counties are doing (calling individual counties' radio rooms), making sure that all cameras are on and 511 system is up and running, etc. Reports are sent to the area command every 2 hours. Restructuring of the ICS program (ICS preparations and conditions reporting) was motivated by problems during Valentine's Day storm in 2007 when many motorists were blocked on the rural roads for 24-48 hours. PA DOT now executes table-top exercises twice a year (at beginning of winter for winter events and at the end of winter for flooding) to train for potential incidents in future. Last year (2011) there were 20 inches of rain in 24 hours which caused flooding during which 500 bridges were lost. John Flaming is PA DOT Incident Management Coordinator (NIMS) on the state level. PA DOT incident management policy is to handle first small responsibilities/

incidents locally and then as an incident grows to involve others. Each district handles incident management in a slightly different manner which is justifiable considering that various districts need to be flexible during incident operations.

3.3.7 Reliability and Performance Measures

Battery back-ups work for 45 minutes after power goes off. The replacement costs are US$ 16,000-20,000 per sign/site. The main fiber-optic hubs are covered with battery back-ups. PA DOT uses a 'smart work-zone' system to inform public about expected delays when closing tunnels or establishing work zones. Contractor is not restricted on how many lanes can be closed as long as the delay does not exceed predefined delay limit. Performance measures such as detour travel times are used in conjunction with Bluetooth readers, cameras and other ITS devices to provide drivers with accurate work-zone delay estimates.

3.3.8 Highlights

After conducting field visit to Pennsylvania DOT TMC, the following observations are marked as the most important to UDOT professionals:

- TMC manager recommends attending the “Operations Academy for Senior Management” at the University of Maryland
- PA DOT has a fully-automated weather responsive (triggering) system to provide warnings in the early stages of a storm

3.4 Ohio (OH) DOT

OH DOT, which consists of 12 districts, has a newly created TMC, which uses using existing office-like floor space. Former TMC with a video wall was outdated and removed. New video wall was not installed because management did not see a purpose when all of the functionalities can be achieved with individual working stations for TMC operators. Each workstation has six wide-screen monitors and there are few (shared) single monitors on walls around the control room. The TMC has a statewide coverage and has been centralized since January 2011. All control room operators are Full-time Employees (FTEs) whose wage is 16-20 $US per hour. One of the working stations is dedicated for traffic signals. A “Radio Room” (a desk station in a separate corner of the control room) exists within the TMC to take public phone calls and communicate with road maintenance crews over the statewide radio network. Natural lighting is extensive throughout the TMC. TMC operates on 24/7 basis and provides weekend coverage (shifts 5 AM – 1:30 PM; 1:00 PM – 9:30 PM; 9:00 PM to 5:30 AM). The total workforce consists of 12 operators and 2 supervisors. Each operator (total of six) covers a unique regional area during peak periods. At night an operator is responsible for multiple areas.

3.4.1 Traffic Signals

OH DOT utilizes both CENTRACS & TACTIC central signal systems. OH DOT staff likes both systems but they give small advantage to CENTRACS which is user friendlier. Both systems can create alarms when the power goes off and a signal is on battery. OH DOT has adaptive ACS-Lite control installed in Pickerington OH and the system operates well. They are also looking into pilot field deployment of InSync. OH DOT provides a traffic signal training program for signal system designers and technicians, for both internal employees and consultants/contractors . They have a comprehensive curriculum (Phase 1 – Basic; Phase 2 – Advanced) for this program and the program is required for promotion. OH DOT has a practice of installing reflective aluminum back plates around signal heads (2” border) to increase signal visibility during nights and low-visibility conditions.

3.4.2 ITS Maintenance

Signal & ITS maintenance are organizationally combined. OH DOT has 5-year warranty on ITS & traffic signal devices and replace them after 10 years (no repair). There is an asset management plan for expensive ITS equipment. OH DOT has installed battery backup units at every signalized intersection. This policy has been implemented for the last few years. At the same time - some major ITS devices have UPSs but not all. The battery backups are supposed to be replaced every 5 years. Beacon lights (light-emitting diode (LED)) are installed on battery backup signals to know that a traffic signal is on battery backup. Wind turbines/generators are used as backup options for solar energy.

3.4.3 Weather Information

OH DOT uses ScanWeb platform which is based on RWIS data/database. Their system can report real-time meteorological data. After analyzing weather conditions maintenance dispatchers, who are located at districts' offices, give instructions to truck operators – e.g. how much salt to disperse and where to drive. OH DOT is unique for its ability to share and visualize RWIS data with truck operators, who are taught to know how to interpret numbers from RWIS reports. Another interesting practice is that dispatchers run 24-hour blogs during storms to share conversation with maintenance crews.

3.4.4 511 Web Traveler Information System

OH DOT has developed their in-house ATMs software (Buckeye Traffic). Information technology staff, who helps with maintenance and development of new applications for Buckeye Traffic, is part of OH DOT. There are 2 programmers and project manager (maybe two more employees) who are responsible for development and maintenance of Buckeye Traffic. The platform will soon change name to "OH GO". One of the future functionalities that will be provided is travel advisory based on weather conditions.

3.4.5 Performance Measurements

OH DOT measures how much time it takes for speed to recover to pre-weather-incident speed. Their system triggers analysis based on RWIS data, which are combined with travel time data. OH DOT uses this recovery time (it takes during snow removal to recover to normal speed) as a performance measure of its operations during snow-removal operations. For work-zone operations OH DOT requires that ITS devices are kept operational during construction. If an ITS device is down financial penalties are imposed on contractors until the ITS device is again operational. This incentive minimizes construction-related down times of OH DOT ITS devices. In addition, OH DOT uses real-time work-zone performance measurements (e.g. queues) powered by INRIX data. Their goal is to track work-zone performance measurements and provide travel advisory based on road conditions.

3.4.6 Emergency Management

OH DOT role is to identify places which needs assistance and then to inform police, fire fighters, etc. OH DOT is considering adoption of a program similar to RISC (Rapid Incident Scene Clearance) program in Miami-Dade County, FL. The RISC Program is an incentive-based program that provides financial compensation for the complete clearance of major traffic events within specified time frames. Bills for removing commercial vehicles from the roadways are paid by truck companies – DOT pays only incentives to remove vehicles blocking lanes as soon as possible (RISC). The contracts for RISC program are only awarded to top prequalified firms who have ability to quickly remove commercial vehicles from roadways with incidents.

3.4.7 Highlights

After conducting field visit to Ohio DOT TMC, the following observations are marked as the most important to UDOT professionals:

- OH DOT has a practice of installing reflective aluminum back plates around signal heads (2" border) to increase signal visibility during nights and low-visibility conditions. Signal & ITS maintenance are organizationally combined
- OH DOT has 5-year warranty on ITS & traffic signal devices and replace them after 10 years (no repair)
- OH DOT has installed battery backup units at every signalized intersection
- OH DOT is unique for its ability to share and visualize RWIS data with truck operators, who are taught to know how to interpret numbers from RWIS reports
- OH DOT is considering adoption of a program similar to RISC (Rapid Incident Scene Clearance) program in Miami-Dade County, FL

3.5 Virginia (VA) DOT

The TMC Layout and functionalities were result of a long-term (3 years) planning process which defined processes and how various partners should work and coexist in the same place. The control room floor combines operations of four agencies responsible for emergency response in Fairfax County, Virginia. (1) VADOT TMC; (2) State Police dispatch; (3) Fairfax County Fire dispatch; and (4) Fairfax County Police dispatch. Number 3 and Number 4 includes the county 911 call center. Also in the building complex: Fairfax County Crime Scene Investigators (CSI) and the State Emergency Operations Center Control room layout, ergonomics, and lighting were carefully designed before the center was built. Work surfaces are adjustable. The State Emergency Operations Center demonstrates extensive use of the NIMS command structure. Also, alternate sites have been set up in case the building needs to be evacuated. The first priority of the TMC and its staff is traffic flow management and incident management. TMC covers 2oo miles of interstate facilities and primary arterials with traffic signals (which have been added recently). TMC policy is to support major events and road closures and do not get involved for small events that do not significantly impact traffic. The TMC manager is responsible for inter-agency facilitation. This includes a monthly coordination meeting of operational agencies (BUS, METRO, TRAFFIC) from Northern VA, D.C., and MD. There are several procedures in place that need to be followed to propose and implement operational changes at TMC.

3.5.1 Control Room Operations

Operations in the control room are clearly divided among individuals with exact roles and responsibilities. Working in a multi-agency environment provides excellent opportunity for information sharing and dissemination. The fact that multiple agencies are located in the same room helps with reducing incident response time due to good communication, quality procedures, and close collaboration between various agencies. TMC manager has a lot of system engineering background that helps him with understanding various technologies and procedures executed at the TMC. Special security screening procedures are needed to enter control operations room. The reason for extra security is that a lot of confidential information is handled and the access to this information should not be allowed to anybody except TMC-control-room staff. All of the control room operators and supervisors are contracted employees. The TMC control room has bullet-proof glass, specially reinforced walls, and back-up communications.

All of the TMC-control-room procedures (from security to operational) are totally focused on the traffic management job with minimal distractions for the control room staff. Networks and communications of various agencies are separated which make physical collocation of various agencies more important on human (than technological) aspect of operations.

3.5.2 Public Relations

Public and media cannot enter the TMC control room – the only place from where visitors can watch TMC operations is the second-floor conference room with a window looking at the TMC control room. There is public relations (or public information) team that handles all calls from the public and the media. In this way operators are not disturbed during their work and their time is used efficiently for traffic and incident management tasks. There is no public information interface with the TMC building – phone numbers of the operators and management are not published, etc. All of the public calls about traffic operations are redirected to VA DOT's personnel who answer those calls.

A single vendor manages access to the data feeds from the TMC (video streaming and traffic data) and is responsible to distribute the data to all interested third parties. The vendor charges for the data released to the third parties and a part of that revenue comes back to VA DOT TMC.

3.5.3 Incident Management

VA DOT has both an Incident Management Team (IMT) and a Safety Patrol program in place. VA DOT runs around 70 safety patrollers-trucks with Dynamic Message Signs (DMSs). Customers can call 1-800-for-road. TMC operators monitor number of assistances and analyze incidents, which helps them to understand correlation between congestion (where it is occurring) and calls for assistance. Analysis is based on crash statistics (incidents), traffic flows (hourly) and impacts of the incidents on queues being formed and overall arterial traffic conditions. This analysis further helps in determining patrollers' routes, return frequency and coverage (e.g. longer roads are split in shorter segments). Routes are ranked in terms of performance and they are prioritized to determine number of vehicles for service patrol. Operators are assigned specific routes (10-hour shifts), and these assignments are rotated for the purposes of cross-training. Main incident-related performance measure is duration of clearance times. VA DOT also employs a quick-response towing program where a tow truck is being sent with the dispatch of a trooper. The tow truck company is paid $35 for a “dry run.”

3.5.4 511 System and ATMS Platform

VA DOT TMC’s ATMS software is called “OpenTMS” (trademark) and it is designed by Open Roads Consulting. The platform is being replaced right now. TMC staff is not very happy with some of the features and the fact that any new functionality has to be programmed in such a way that it affects the entire software. VA DOT issued an request for proposal for a new “off the shelf” software product, which should be modular and developed in such a way that 80-85% of the functionalities are “off the shelf” and the rest are customized for individual VA DOT TMC needs. Regarding 511 phone system, similar to notions from other states, it is noted that most of the people do not call 511 phone systems but use smart phones applications (provided by a consultant) to find out about traffic conditions. VA DOT TMC can pull up information from 15,000 detectors which provide counts, speeds, and vehicle classification. Archival of the ATMS historical data is done through in-house software developed by University of Maryland.

3.5.5 Traffic Signals

TMC is responsible for signal traffic engineering; it manages 1400 signals in northern Virginia. VA DOT traffic engineering services (which are located in the other building) handles signs, geometrical improvements, etc. The signal timing group has an office just off the control room floor. VA DOT utilizes MIST-central signal control system which was developed by TELVENT. Signal retiming is performed on a per-needed basis and MIST is a platform that can integrate adaptive traffic control systems in its operations.

3.5.6 Winter Maintenance

All of the weather information comes from VA DOT headquarters in Richmond in 15-minute update intervals. Snowplow operations are not part of TMC. Maintenance offices (areas within regions) handle snow removal while head of central maintenance comes to coordinate operations. RWIS is present but it does not automatically trigger any automatic responses.

3.5.7 Active Transportation and Demand Management

VA DOT manages a reversible (gated) HOV facility on I-95 which has 21 gates and dynamic message signs. There are also 3 reversible lanes on I-66. Variable Speed Limits (VSL) will be deployed in about 6 months (under construction right now) on I-66. VSL will be driven by congestion or incidents. The speeds posted on VSL signs will be regulatory speeds (not advisory). VA DOT uses lane-control strategies (with signs which are archaic and will be replaced soon) for hard shoulder running. They plan to introduce a scheduled lane-control on hard shoulders. Freeway ramp-metering is managed by VA DOT signal timing staff. However, there is a notion that ramp-metering in VA does not help much; maybe due to over-congested traffic conditions.

3.5.8 Asset Management

The communications infrastructure at the TMC has multiple redundancies and back-ups. VA DOT owns a fiber network. VA DOT contracts out maintenance of ITS devices. Life-cycle cost of devices is not performed. Portable video trailers with diesel generators are also being used. They are supplied by WANCO. Mobile cameras are mounted on IMT trucks that transmit back to the TMC over a 4G cellular network.

3.5.9 Highlights

After conducting field visit to Virginia DOT TMC, the following observations are marked as the most important to UDOT professionals:

- The control room includes fire dispatch
- They use a public relations team that handles all calls from the public and the media
- A single vendor manages access to the data feeds from the TMC (video streaming and traffic data) and is responsible to distribute the data to all interested third parties
- Mobile cameras are mounted on IMT trucks that transmit back to the TMC over a 4G cellular network

<u>4.0 SUMMARY OF WESTERN STATES</u>

4.1 Overview

This chapter summarizes impressions from field visits to TOCs in the western states of US. Field visits were conducted in Sacramento and San Francisco in California and Kansas City in Missouri. At the end of each subchapter (covering a single TOC) relevant highlights from the corresponding visit are presented.

4.2 Caltrans Sacramento TMC

Caltrans is divided in 12 districts, 6 of which are in urban-metro areas while 6 are in rural- urban areas. District 3 encompasses Sacramento metro area. Five TMCs (statewide) are non 24/7 centers whereas the others are centers that operate on 24/7 basis. Five of the TMCs are collocated with dispatch/911 call centers. Also, four California Highway Patrol (CHP) call centers are within District 3. There are around 820 Caltrans signals in District 3. However, although Caltrans is owner of these signals, they are operated by Sacramento County, which has control over most of the signals in the area.

<u>4.2.1 ATMS Software</u>

District 3 TMCs use multiple ATMS software within each facility, some of which are DELCAN software, MN DOT, TMCAL, TMCAD, Bears etc. There is a variety of homegrown open-source software and commercial software which were deployed for various reasons. History of funding/resources allocation played the most important role in acquisition of various software platforms. About 8 years ago 75% of funding for transportation projects was controlled by local agencies, whereas Caltrans retained control over 25% of the allocated money. This resulted in the fact that each local agency deployed customized software for their needs. This law gave local agencies enough resources to pay for modifications of the state systems and for this reason various systems that all started from the common system-predecessor migrated from each other. A consequence is that there is a problem to get various systems & their data integrated. Caltrans preference would be to have a statewide system than integration of various systems. Caltrans owns ramp signals but they have been turned over to local agencies to operate. Rural locations are still operated by Caltrans, who has cooperative agreement with Sacramento County. There are ITS partnership meetings which occur on monthly basis and which help cities and counties to achieve much better coordination.

4.2.2 Video Wall

Sacramento's TMC video wall utilizes the old rear-projector technology and it will remain to utilize the same technology for a while. Sometimes video wall is turned off to save energy and extend life of the projector lamps. Video wall loses its importance with multiple screens installed at each operator's station. CHP staff communicates with TMC operators through CAD and by text messages.

4.2.3 Control Room Operations

Caltrans TMC in Sacramento employs operators in the TMC control room (Caltrans staff). Also, the TMC staff stays in place much longer (do not rotate) than Caltrans employees in other offices. This approach prevents dissipation of knowledge and expertise of TMC staff. On the other hand, TMC contracts employees for ITS communication work. Statewide IT department controls IT groups in individual Caltrans districts but districts have good working relationship with their respective IT groups.

4.2.4 Ramp Metering

Storage lengths for some ramps were not originally built for ramp metering and for this reason traffic sometimes backs up from ramps to arterials. The overall goal of CALTRANS ramp-metering systems is to brake-up platoons and maximize flow on freeways. Metering rates are established based on ideal mainline speeds and estimation how these rates will affect traffic backup. Queue detection is present on the ramps but it is not extensively used (loops are at the entrance of the ramp). Sacramento TMC's approach is to keep the queue within length of the ramp and do not exchange delays between freeways and arterial roads (e.g. reduce freeway delay to increase arterial delay). One of the major constraints in Sacramento road network is the fact that there are (only) four crossing points over the river from North Sacramento to South Sacramento. This significantly influences traffic on crossing roads and thus ramp-metering operations which are in effect from 6-9 AM and 3-6 PM. If the traffic demand on ramps is low then signals show green balls. The ramp-metering system is local-responsive (900 veh/hour is maximum rate). There are 6 ramp-metering programs in the state of California. Various districts use various types of 'triggering mechanisms'; District 3 triggers ramp-metering operations by occupancy whereas some other districts trigger operations by time or traffic counts. There are currently 119 ramp meters and 100 monitoring stations in District 3.

In spite of the fact that there is no formalized warrant process for ramp meters they are planned for any new interchanges and freeway facilities. There is an environmental quality law which requires that a intergovernmental review group prepare comments for local land-use developments in advance. This process helps with identifying need for additional ramp-metering facilities. Ramp meter operations are not currently integrated into ATMS software. Depending on location of ramp meters the District uses 'one-vehicle-per-lane or two-vehicles-per-lane' policy. There is a notion that two-vehicles-per-lane approach is not as efficient as one-vehicle-per-lane because it is not intuitive and it requires extra effort to train drivers. Caltrans utilize freeway-to-freeway (system-to-system) ramp metering and there is even one place (in san Francisco area) where mainline-to-bridge ramp metering is utilized.

4.2.5 Weather Operations

Caltrans establishes a winter maintenance/operation center (in Kingsville?) for operations at Donner Pass, which is utilized to communicate directly to maintenance crew (although it is done in informal way). The goal of the center is to keep road open (at Donner Pass) at all costs.

There is no need for RWIS considering that maintenance crews are up there constantly (putting out chemicals, removing vehicles that block the road etc.). During the chain-operations (when chains are mandatory) the speed limit is reduced to 35 mph. Good thing about ice & snow conditions in California is that do not last for long period of time (storm comes in dump its content and it warms up). Around August-September Caltrans pull out its vehicles from valleys and moves them to mountains. While during summer Kingsville has ~ 6 maintenance vehicles during summer this number goes to ~ x vehicles (13-20 graders, 20 10-yard snowplows). The whole system of operations is changed to be maintenance-driven during winter months. Push trucks, which are run by tracking associations, are used to push trucks uphill (pushing trucks are more effective (more traction) than pulling). Graders cut ice-pack down and snow snowplows move snow to the side. There are multiple chain control points (usually every half a mile) where it is checked whether vehicles have chains on wheels of their vehicles. Caltrans holds a meeting, before winter season, with other interested parties (CHP, trucking association, local agencies) to discuss preparation plans for the next season (any changes are discussed). Changeable message signs, HAR, & other parts of public information systems are deployed. There is no ambiguity during incidents - CHP gives incident commander during incidents. There is a notion that north Caltrans jurisdictions know how to handle snow and keep roads open while south jurisdictions (where snow is much rarer) do not utilize chains at all but just close the road if conditions are too bad. Recently, Caltrans started making change in the way it treats roads and they are shifting from salt to liquid brine applications.

4.2.6 High-Wind Operations

Highway sensors send information to operators who will then post warning messages and advisory speed information on VMSs. A wind speed which triggers operators' actions is 25 mph. The issues with winds are more common in southern California, while both southern and northern California have another serious issue which is fog. There are essentially two types of fog systems. First, in the northern California (in Stockton area) when visibility gets down to certain level information is sent to TMC, and the TMC will put up a warning sign. Second, in southern parts of the state, there will be a set of recommended speeds (advisory speeds) which are presented to drivers at ~300 ft intervals (e.g. 1500 ft, 1200 ft, 900 ft, 700 ft) ahead of the reduced speed/visibility. Fog usually comes in packs - it may be very sudden, it may happen sporadically in space and conditions can change very quickly. A sign cannot be put up before it is sure that a condition is happening. Caltrans is working closely with National Oceanic and Atmospheric Administration to be properly informed about incoming weather conditions.

4.2.7 Variable Message Signs

In California, VMS signs can be used for advertisement; currently CA is working with few other states (PA and FL) on changing Manual on Uniform Traffic Control Devices (MUTCD) to allow for advertisement. Caltrans is looking into agreements with media companies (CBS, Clear Channel, etc.) who would provide full-matrix signs and (replace Caltrans VMSs) to provide full capability of visualizing commercial videos. The benefits of such agreements are that Caltrans would get an ITS element for free and it would participate in revenue sharing. On the other hand, Caltrans does not allow advertisements on incident response tracks (or any state vehicles or state signs) but they do not have systems like road rangers or other similar services. All of the towing is done by service patrol trucks which are contracted in metropolitan areas for congestion management or in specific maintenance construction areas. Road-ranger-type of services are provided usually by local transportation authorities, which fund those services (including towing, gas, tire changes etc.) from Congestion Mitigation and Air Quality (CMAQ) money.

4.2.8 511 Phone System and Public Information Office

A lot of cities in California started 511 phone systems before federal authorities pushed for it. So, there is a history of implementation of traffic-related Interactive Voice Response (IVR) systems in California. Older population likes IVR system while younger population prefers web-based tools. In the future Caltrans want to continue supporting 511 IVR and web applications in addition to data warehousing. Caltrans wants to make data at the warehouse friendly for apps but it does not want to become an app's developer). All of the Caltrans data is available for free to public and any 3rd parties. There is no Public Information officer in TMC. If there is one assigned, he/she usually is too busy with other things and may be present in TMC only few days per week. So, from Public Relations/Communication perspective CHP is the face of TMC.

4.2.9 Road Closures and Work Zone Operations

There are two separate classifications of staff on the floor: operators and dispatchers. Both TMC and CHP have their dispatchers on the floor. TMC dispatchers’ role is to call and issue task orders to Caltrans maintenance staff. Number of operators goes down during night to one operator and one dispatcher. Usually there are around 60,000 maintenance and construction statewide closures per month. Caltrans is looking into enabling its maintenance staff to use apps (instead of calling in operators) to record road closures. It is Caltrans policy that only low-volume roads can close one lane for limited time without approval. All other closures need to be approved, entered in the maintenance database, and have ability to query their status. All of the closures need to be approved 7 days in advance (there are always exceptions; some are last-minute changes).

Caltrans is looking in development of internal apps (as opposed to those available to public) to automate their maintenance and lane-closure processes and tracking to eliminate any single-point bottlenecks in the way that these processes are administered. A resident engineer on the roadway project is responsible for closures. Another approach that Caltrans is looking into is adding incentive and disincentive to the contractor - to encourage that prime contractors are more aware of how subcontractors schedule road closures. Caltrans has a permit inspectors and area supervisors who are taking care of providing inspections. Caltrans database is capable of tracking denials for road closures. Right now the link closure system database is hosted by an ORACLE system but Caltrans is looking into migrating from ORACLE to another (internally manageable) platform.

4.2.10 High Ocupancy Toll (HOT) and High Ocuppancy Vehicle (HOV) Lanes

In the state of California there are two 2 different types of HOT facilities. Caltrans districts in the southern parts of the state use separated-access facilities while those in northern parts of the state use open access HOT lanes, which are often also HOV lanes. For example, San Francisco district uses an open access approach with a lot of transponders along the route. CHP is helping to catch HOT violators. Video enforcement has been one way to reduce number of violators but there are multiple problems (e.g. glaring, back-seat infants) which are making this approach ineffective. There are usually 50-60 new HOV/HOT facilities which are added, statewide, per year.

4.2.11 Hard-Shoulder Running

Hard-shoulder running is not used in Sacramento area but it has been done in San Francisco and San Diego. It is based on time-of-day schedules and exclusively implemented by buses. Hard-shoulder running is not implemented on state freeways (shoulders are not structurally supported) but it is implemented on arterial streets. San Diego Integrated Corridor Management project may implement hard-shoulder running on freeway facilities.

4.2.12 Variable Speed Limits

VSLs are not implemented right now. The first implementation will most likely be on Carquinez Bridge on I-80 in Alameda County. One of the problems with VSL is that they are lane-based as opposed to dynamically changing the speed on the whole segment. CHP does not like individual lane control but is ready to enforce segment control. California laws do not allow use of video enforcement for speeds but it can be used for traffic signal operations. There is currently a demonstration project with a CHP van in work zones (monitoring behavior of vehicles in work zones). Photo enforcement can be done for citation purposes but instead the system is used to warn drivers. CALTRANS experience with photo enforcement is that it usually lasts for about 3 years after which time is usually removed.

4.2.13 Highlights

After conducting field visit to Sacramento TOC in California, the following observations are marked as the most important to UDOT professionals:

- San Francisco TOC staff use a wind speed of 25mph to trigger operator’s actions
- Caltrans is looking into agreements with media companies (CBS, Clear Channel, etc.) who would provide full-matrix signs and (replace Caltrans VMSs) to provide full capability of visualizing commercial videos
- Caltrans wants to continue supporting 511 IVR and web applications
- Hard-shoulder running is implemented on arterial streets

4.3 Caltrans San Francisco TMC

Caltrans' TMC in San Francisco is one of the TMCs which operate on 24/7 basis and it picks up responsibilities of the neighboring (South & North) TMCs. Caltrans has a statewide dynamic map (511 system), whereas each district has its own 511 system. The TMC in San Francisco was built in 1996 and it hosts emergency operation center in the same place. The TMC hosts CHP operators, 511 staff (which is physically divided from control room) and Caltrans TMC operators. The current TMC setup allows for effective communication between various agencies in the case of major incidents.

4.3.1 Video Wall and Control Room

San Francisco TMC has a large video wall with system map displayed in the middle screens and individual CCTV camera feeds on the outside screens. The video wall consists of 35 45-inch LED/LCD single-projection monitors manufactured by Barco. The old video wall was the same in its size it just had different technology (rear projection) for the monitors. When the old monitors were replaced by new one rearrangement of floor plan was not considered. Similarly to UDOT, the San Francisco Caltrans staff performed a TMC tour (~ 20 years ago) to find out the best practices in designing and operating a TMC. They are quite happy right now with existing floor spacing and number of TMC stations. However, their traveler operation services are physically separated (2nd floor) from traffic operations, which are in the control room. All of the TMC operators are CALTRANS employees, whereas 511 staff is contracted. One of their problems is a variety of classifications and pay groups on the floor of the control room. Sometimes, similar work is done for a different pay, depending on to which group an operator belongs. Most of the construction activities are done during night which keeps TMC operators (who work 24/7) busy. Also, sometimes they do operational tests during night.

4.3.2 ITS Infrastructure

The District 4, to which San Francisco TMC belongs, operates around 300 cameras. Video feeds from these cameras are not recordable and they are not shared with media. Some of the cameras' feeds are available to public thru 511 Advanced Traveler Information System (ATIS). Media groups have their own cameras which are usually placed on Caltrans Right-of-Way (with permission from Caltrans). On the other hand multiple cities and counties in the area have surface-street cameras. District 4 has 137 VMSs, which all have standard 3-line 16-characters displays. VMSs are operational from 5 AM to 9 PM for travel time displays. From 9 PM to 5 AM VMSs are dark (to save energy). There are also 25 Highway Advisory Radio stations and 2-

3 VMSs are associated with each HAR station. The San Francisco TMC has similar problems with theft of copper wire and they do not seem to have a good solution for this problem.

4.3.3 High Occupancy Vehicle/Toll Lanes

There are currently 2 HOT lanes that operate in the Bay Area but this number will soon increase to 10 HOT lanes. The ultimate goal of District 4 HOV/HOT program is to turn all of the car-pool (HOV) lanes to express (HOT) lanes. All of the HOT lanes can be accessed through FasTrak toll system which utilizes common car-tag reader technology. District 4 has an agreement with CHP to enforce the use of HOV/HOT lanes (this is supported by extra pay for CHP officers, etc.). During the incidents CHP officers in field can make decision to open HOT lane for general public. Sometimes traffic immediately start using this lane in the case of incident which causes a problem to cancel charges which are being made to cars with tags who used the lane only due to the incident. Various agencies (HOT lane operators, Caltrans, CHP, etc.) are still trying to develop a concept of operations of express lanes to define exact protocols that would be used in such situations.

4.3.4 Traffic Management

Information about events is obtained from venues (organizers call TMC) but also TMC keeps tracks (by looking in schedules) of the major sport events. TMC has been able to plan and prepare an increased number of cash toll collectors for events & weekend traffic. Freeway service patrol is co-managed by CHP, Metropolitan Transportation Commission (MTC), or Caltrans by dispatching of the vehicles is done by CHP. 511 does not get involved into management of the event traffic itself but it tries to minimize the impact of the event-driven traffic on the rest of travelers. On the other hand service patrol is responsible for incidents but they do not do traffic control. Toll services for bridges are dispatched from TMC. There are 7 bridges which need to be maintained (traffic operations). Also, there are 4 major projects that are currently going on: SFO-Oakland Bay Bridge, Presidio Pkwy, Caldecott Tunnel 4th Bore, and Devil's Slide Bypass.

4.3.5 Ramp Metering

There are 298 operational ramp meters. In addition to that 200 ramp meters are programmed to be deployed by 2013 and there are additional 695 ramp meters which are planned but the funding is not available yet. The system uses local ramp-metering but there is a plan to adopt an adaptive ramp metering logic sometimes in future. At some other locations in CA (e.g. LA) ramp metering functions were controlled through DELCAN's ATMS platform that allowed for system-wide adaptive ramp metering (SWARM). However, this type of ramp metering was not proven to be very effective. The District 4 is still considering which of the existing algorithms should be utilized for adaptive ramp metering. It is a key thing to understand that ramp-metering is implemented based on political decisions (locals need to push for ramp-metering) and it is not a simple engineering decision. Sometimes, on traversing freeway sections, local authorities may not like that flow is improved for go-through drivers while the locals are penalized at ramp meters.

4.3.6 511 System and Public Relations

Public relations are responsibility of 511 services. Public communication is not handled by traffic operators. District 4 511 services are located in a separate (2nd floor) room due to space constraints. 511 traveler information center works 24/7 and it contains phone & web services. The goal is to provide information as soon as possible but also as consistently as possible. Normally, the 511 center has staff of 3 operators out of whom one seats in TMC control room while two are upstairs (in the 511 center). CHP CAD system is center's primary source for information about traffic information and incidents. Additional sources of information are tweets, emails, information that is broadcasted on radio, etc. The center has one twitter account and the tweets are given out and received in. Information about major incidents (those that last 30 minutes or longer) are twitted out (threshold is 50% of lanes). The 511 centers has developed smart phone apps which are free (android & iPhone) - called 511 transit trip planner. The same type of transit trip planner is available as a web page. The center has seen large raise in usage of 511free apps during major chokepoints. Regarding the 511 phone system - more important messages (about high-profile incidents) are given higher priority in 511 telephone system. Unlike in Utah, amber alerts are not done thru 511 systems.

4.3.7 Incident Management

Caltrans District 4 has a Traffic Incident Management (TIM) plan that covers management of express lanes during incidents. At the same time traffic responsive plans are run on arterial streets and are used during incidents on freeways to divert traffic on arterial streets. Caltrans District 4 has a Traffic Incident Management program. MTC is meeting with local agencies to look at strategies to facilitate quick clearance during incidents. They are also looking into development of apps to report incident (e.g. take a photo, answer few questions, send geo coordinates, etc.). It is a pilot project where operators will be remotely entering information about incidents into an app. TMC has a lot of communication with other stake-holders and they are meetings to brainstorm & coordinate incident responses. These agencies are part of the Incident Management Task Force which meets monthly to discuss incident response issues. Also, there is a bigger coalition (with more agencies) that meets on quarterly basis. Caltrans District 4 does not have any special program for a quick removal of disabled vehicles from highways. However, CHP has a rotation tow program (list) which provides for safe, efficient and rapid removal of disabled vehicles or vehicles involved in collisions from highways served by the CHP. District 4 has sign trucks which can be dispatched and deployed during major incidents.

4.3.8 Highlights

After conducting field visit to San Francisco TOC in California, the following observations are marked as the most important to UDOT professionals:

- The video wall consists of LED/LCD single-projection monitors manufactured by Barco
- Ramp metering functions are still being investigated; there does not seem to be a single approach which is superior to others
- The 511 centers have developed free smart phone applications

4.4 Kansas City - SCOUT TMC

SCOUT represents a joint effort of MO & KS Departments of Transportation. SCOUT is accessible through several way including mykcscout.com (including web alerts), tweeter, and http://www.kcscout.net web service. Development, operations and maintenance of the TMC represents a true bi-state effort. The original location of TMC was Kansas City downtown area but it was moved to Lee's Summit. All of the operational costs are shared between MO & KS in proportions 60/40. The TMC used to be a 24/7 customer service facility but since recently it was changed that Saint Louis provides customer service after 9 PM until morning. The SCOUT remains 24/7 traffic management facility. Branding SCOUT to establish a recognizable name for people in the area was an organized effort. MO DOT and KS DOT hired a marketing firm to help with branding. Both DOTs are making significant branding efforts.

4.4.1 Traffic Signal Operations

SCOUT enjoys very strong support from the local MPO which runs an arterial improvement program called "Operation Green Light" (OGL). OGL project encompasses a group of the most important corridors that cross jurisdictions and require signal retiming. As a part of OGL project Genetec's Omnicast video surveillance system is supposed to be integrated in TransSuite in such a way that video feeds will be viewed in TransSuite arterials. Interfacing OGL with SCOUT is still a challenge considering number of traffic signals (700) and number of various agencies who have jurisdictions over those signals (22 cities). SCOUT has around 300 CCTV cameras in the metro area. SCOUT does not archive video but some shorter video feeds may be recorded only for internal training purposes. There are usually 8-10 requests in a week for recorded video but SCOUT does not store and provides its video feeds to the third parties. However, control over cameras (pan, zoom) can be given to any inside (MO DOT and KS DOT) staff outside of the TMC (SCOUT). SCOUT is interested to know more about results of a project conducted in Saint Louis where local traffic signal jurisdiction investigates utilization of the innovative ITS traffic data collection devices (such as Sensys, TrafficCast, and arterial DMSs) for signal retiming purposes.

4.4.2 Ramp Meters

There are only 15 ramp meters operated by SCOUT. They are all closely spaced ramps installed on I-435 - an East-West freeway that crosses border between MO and KS. There are currently no system-to-system ramp meters. Existing ramp meters are installed on ramps which are not properly designed for ramp meters - they have short acceleration lanes and advanced queue loops. Currently, traffic responsive software developed by DELCAN is used to clear the queues. Another DELCAN software called CARMA (Corridor Adaptive Ramp Metering Algorithm) utilizes a ramp metering algorithm which is based on occupancy. CARMA automatically turns itself on between 6:45 and 8:45 AM, and from 4:15 to 6:30 PM. Hardware for ramp metering controllers is provided by DELCAN - special field computers with National Transportation Communications for ITS Protocols (NTCIP). SCOUT has a stock of 500-600 of these DELCAN controllers and it is not cost beneficial to deploy different hardware and/or software until these controllers work fine. SCOUT utilizes magnetic radars to detect vehicles on mainline whereas standard inductive loops are deployed on ramps.

4.4.3 High Occupancy Toll Lanes, Hard-shoulder Running and Variable Speed Limits

HOV or HOT lanes are not currently deployed anywhere in the region. Saint Louis (MO DOT District or city) has tried VSL but it had a very limited success. VSLs were not integrated with ATMS and other tools and thus the entire project was set up for failure from very beginning. The VSLs were recently changed to become advisory speed limits but it is expected that they will be completely turned off/ removed in near future. I-435-in Johnson County (KS) operates hard-shoulder running. However, this option is available only for buses and only during peak hours. In addition, buses can run only 5 mph over what the current speed is in the other lanes. On top of that, traffic in other lanes needs to be slower than 35-45 mph. Performance of the hard-shoulder running will be evaluated in near future but preliminary indicators show that this service improves travel time of the buses and increases ridership for about 15-20%.

4.4.4 Control Room Operations

SCOUT has been playing a role of a statewide TMC (de facto) for the last 3 years. TMC operators are contractor's (TELVENT) staff. TMC operators have full training program, procedures, handbooks, etc. The main reason for switching from DOT staff in TMC to the contractor is that DOT has a long term goal to reduce FTEs (have been reduced for the last 6 years). TELVENT has been hired for the last 6 months. Two states MO & KS) work together in incident management to benefit travelers in both states. TMC furniture has been built from the existing in-house furniture. TMC staff (not operators who are contractor's staff) is not being rotated around other DOT offices. Video wall was refurbished by replacing outdated rear-projection video panels with commercial-grade home-TV type LCD screens which represent a cost effective option of providing major features of the previous video wall.

4.4.5 Maintenance of ITS Devices

Currently SCOUT has two persons who are employed in ITS maintenance in addition to a contractor who is responsible for preventive maintenance. MO DOT/SCOUT may reconsider employing more full time stuff for ITS maintenance based on how things will change in future. One of the major communication maintenance problems is copper wire theft, which happened about a dozen times during the last year. Thieves do not hesitate to even excavate buried boxes to steal the copper wire. It seems that like UDOT and Caltrans neither MO (KS) DOT has a right remedy for this problem. All of the SCOUT ITS-related contracts are "cost + fixed fee" contracts.

4.4.6 Incident Management

Incident management is one of the areas where a benefit to travelers of two states working together is easiest to observe. It is very challenging to provide good logistics for incident management and coordination when working with more than 30 various emergency responding agencies. Another challenge represents the fact that there are at least 8 different CAD vendors that provide their software to these emergency-response agencies. For example, Kansas State dispatchers are located in the middle of Kansas and SCOUT plays a crucial role in coordinating emergency response activities in the Kansas City metropolitan area. SCOUT incident management team consists of 17 people and 13 trucks for incident management out of which 8 are emergency assistance trucks, 4 are emergency response trucks, and one is a different vehicle. The trucks are dispatched by MODOT's Traffic Department.

4.4.7 Performance Measures

In terms of event management reporting - SCOUT publishes quarterly reports (trackers) which provide summaries of speeds and travel times and are fairly automated reports maintained by TRANSCORE. It takes about a day to prepare this report. SCOUT will soon launch a website which will report performance measure on monthly bases. Performance measures that will be available include incident information by time of day and day of week, travel time, speed, signal timing-related performance measures and others. In total it is expected that more than 150 performance measures will be reported. SCOUT is looking for a way to perform special reporting. Another thing that SCOUT would like to improve is compatibility of its dispatching software considering that CAD is standalone software and has no connections with other TMC platforms. SCOUT is expecting to see integration between (basic functions of) CAD software and TransSuite.

4.4.8 TransSuite

TransSuite made things, especially Geographic Information System (GIS) mapping, much easier than previous system (DELCAN). It seems that SCOUT staff really like reporting capabilities of TransSuite, which they qualify as "amazing". They are interested to meet with other TransSuite users and organize user group meetings etc. It seems that traffic signal operators are also quite happy with TransSuite's platform for traffic signal operations. Using TransSuite to enter information about an event seems to be a seamless process - everything is done in 4 steps as opposed to many more that were necessary to accomplish with previous software. MO DOT would be ready to let their TransSuite 'guru' to take few days of leave and travel to Salt Lake City to help UDOT establish their TransSuite GIS maps.

4.4.9 Highlights

After conducting field visit to Kansas City SCOUT TMC, the following observations are marked as the most important to UDOT professionals:

- Genetec's Omnicast video surveillance system is supposed to be integrated in TransSuite

- SCOUT does not archive video but some shorter video feeds may be recorded only for internal training purposes
- Johnson County operates hard-shoulder running for buses during peak hours

5.0 OTHER SIGNIFICANT TRANSPORTATION MANAGEMENT CENTERS

5.1 Overview

The number, size, and complexity of TMCs are growing rapidly. Many of the latest TMCs involve staff from multiple agencies and jurisdictions. These centers focus on integrated transportation management, often applying state-of-the-art technology so that both personnel and systems can work together effectively. The experiences of the agencies implementing and operating these facilities can be of great value to agencies considering their own implementations.

TMCs presented in this chapter were chosen based on the significance of the newly employed technologies and methods. Subsequent worldwide TMC practices and experiences emphasize the potential for improvement of different areas of TMC operations in the US. Technological innovations and procedural trends described in the following chapter could be perceived as opportunities to reduce costs and increase efficiency in transportation systems, while enhancing transportation management policies. Some of the described TMCs feature a number of peculiarities that would be valuable to investigate further since they provide highly positive results in their corresponding environments.

Depending on the overall goal and desired results, a specific set of strategies could be applied. Objective associated with such goals may be: enhancements of public transit-oriented services, reduction of congestion during traffic peaks, roadway cost savings, pollution reduction, increased livability and accessibility of neighborhoods.

5.2 Dublin Traffic and Incident Management Center

The City of Dublin’s Roads & Traffic Department is responsible for all aspects of Traffic Management, Road Maintenance Construction, Public Lighting etc. Most important project is the new Tram Project (Dublin Light Rail System) LUAS Cross City scheduled to commence shortly. The Dublin Traffic and Incident Management Centre (TIMC) is operated 24/7 and from July 2013 was upgraded to the Incident Management Centre as well. The old control room was well equipped, with a large video wall and many monitors. Also a separate room existed for discussion only, somewhat isolated in order not to disturb the operators while working. ITS Systems employed include Sydney Coordinated Adaptive Traffic System (SCATS), Fault Management System, CCTV (240 cameras), Heavy Goods Vehicle (HGV) Permit System, Real-time Passenger Information (RTPI) system, Dublin Public Transport Interface Module (DPTIM)-Bus priority.

Figure 5.1 Dublin City Council's new traffic and incident management center

TIMC in Dublin has put the emphases on using the existing technologies for efficient public services. This is mostly achieved by promoting cycling in the city core area (more than 5 million journeys on bikes), the use of mobile phone for parking services payment, and the use of real time passenger information by using open-source technology. Currently, IBM research is undertaken in order to achieve visualisation of locations of buses at the specific point in time by using the AVLC data. SCATS System is central for Dublin traffic management operations. At present there are 754 sites throughout Dublin and other parts of Ireland under SCATS including seven local authorities.

5.2.1 Dublin Public Transport Interface Module (DPTIM)

DPTIM stands for Dublin Public Transport Interface Module for SCATS and represents Centralised Public Transport Priority in SCATS. The SCATS traffic control system has an ITS port to allow a separate module to be interfaced. The Use of ITS provides the possibility of benefits on corridors where hard bus priority measures cannot be provided for engineering or political reasons.

- In Service (yellow circle)
- At a bus Stop (red circle)
- In Congestion (pink)
- Active in a detector (blue)
- No updates (grey)

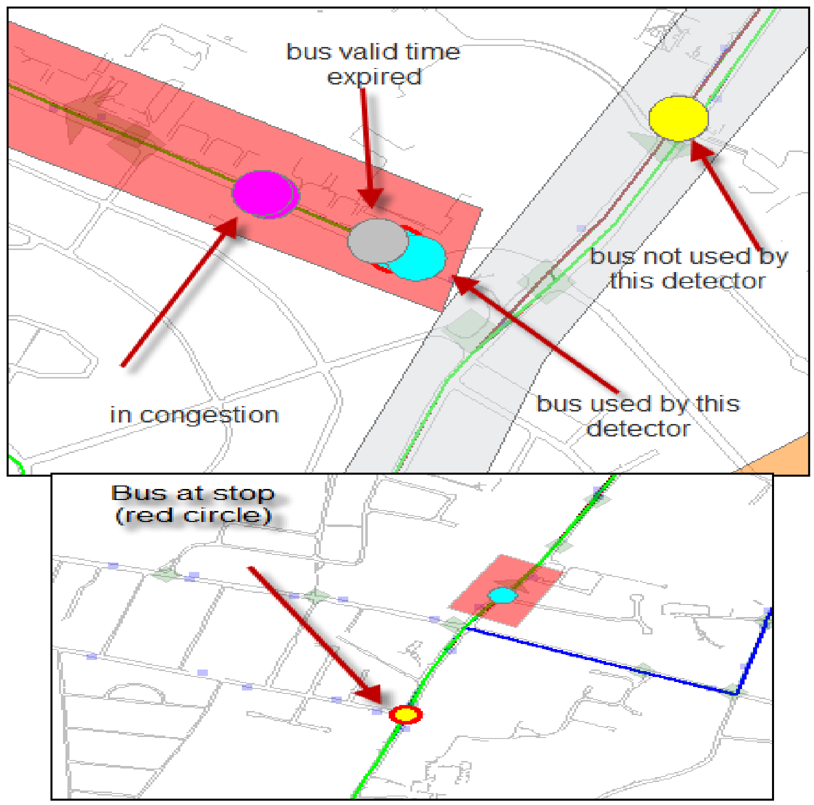


Figure 5.2 Graphic representation of bus status

Real-time information on the location of a Vehicle i.e. Bus, using the International Standard Protocol SIRI is being fed into SCATS. In other words, GPS coordinates of a bus which is currently operation in the public transportation network are available all the time. Aside from knowing the position of a particular bus, there are other advantages of receiving bus status information; such as: congestion indicators (when a bus does not transverse more than 100 meters within 3 minutes), out-of-service indicators, and stop indicators.

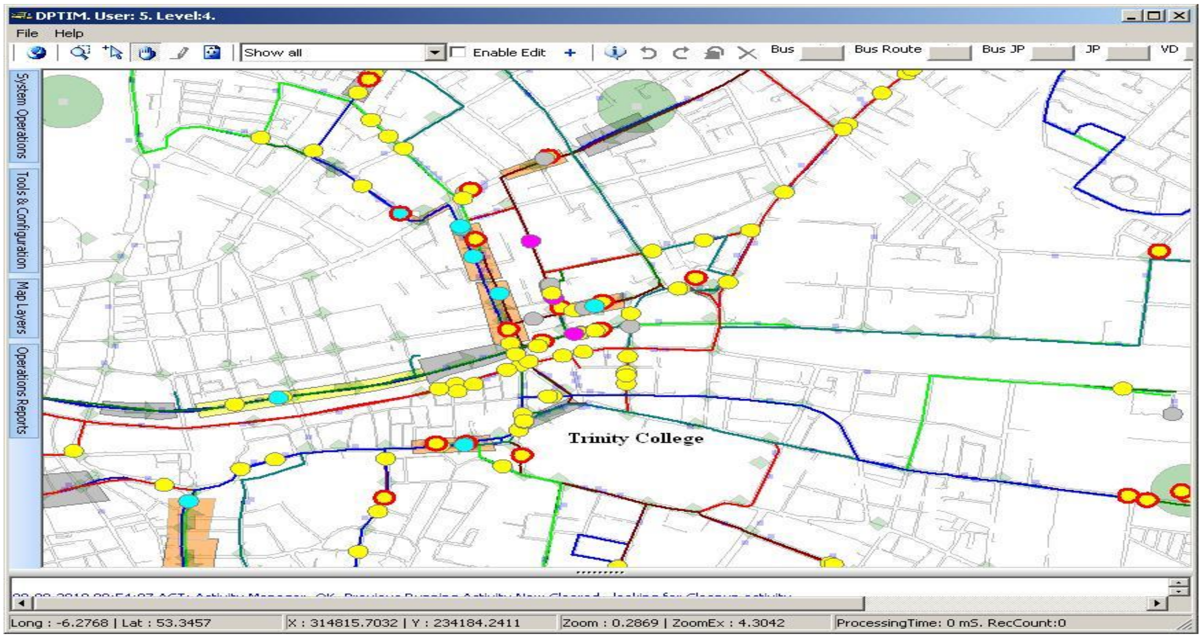


Figure 5.3 DPTIM user interface

DPTIM was developed for the City of Dublin in order to be operable with SCATS. Interchange of information between Automatic Vehicle Locator (AVL) equipped vehicles and SCATS takes place inside the central Dublin City Council (DCC) bus priority server. Based on the detector data available, SCATS executes changes in signal timings. Within the DPTIM system there are virtual detectors (map-based shapes). Detectors can be used for providing bus congestion information. Also they can be used as start or end point for bus journey time analysis. Detectors are then used to alter the network operation of the SCATS system to relieve bus congestion and to help maintain consistent journey times through problematic areas. All SCATS sites can be used by this system as there is no requirement to provide any field equipment. Vehicle detection is accomplished by utilizing around 300 video loop detectors and microwave radars. SCATS communications are operated mostly through General Packet Radio Service (GPRS)-wireless system. Due to reliability issues, important intersections are wired whereas the less important ones utilize wireless communication protocols.

Incident and/or event plans are already in place, within SCATS, each of them is associated with the specific set of conditions. With such advanced preparations of signal timing plans the SCATS operations are made pre-emptive. Traffic control operators manually adjust signal timing plans in order for SCATS to be ready for any expected situations. Virtual detectors call to SCATS's pre-configured plans and actions, identified by Activity ID when Trigger Threshold is reached.

Most significant, on-going, transportation management projects are Dublin Port Tunnel and its complementary HGV strategy City Cordon. The Dublin Port Tunnel is a 5km Urban Twin-Bore Tunnel. It incorporates significant ITS technology such as control centre and incident detection.

Figure 5.4 Port Tunnel in operation

Variable Toll Prices are established in order to promote HGV exclusion from the city's core. The goal of this project is to divert HGVs from the city of Dublin. Pricing structure is as follows:

- HGVs – Free

- Cars - €3 off-peak, €10 peak

By introducing tunnel in operations number of HGVs with five or more axles on City streets was reduced by over 90%. A project called “HGV city cordon” is implemented to encourage maximum use of the Port Tunnel by port-related traffic and to enhance the protection of the city centre environment. The cordon means that the only route from /to the port is via the Port Tunnel. The cordon is enforced between 7:00 AM and 7:00 PM, during the rest of the day HGVs with five or more axles are allowed to use the city Streets.

Figure 5.5 RTPI stop display

Installation of RTPI system for Ireland is accomplished by DCC; 600 displays are installed only in Greater Dublin Area (GDA). All modes of transport are available for display on

RTPI boards. Web Site Apps and Open Data REST Service is now also in place displaying information regarding 12,000 public transportation stops in Ireland; covering all major cities.

DCC provides Open data access to all RTPI data for third parties through a published Web Services Interface. Also queries can be made on Bus Stops; 12,000 stops throughout all of Ireland are available (only stops with electronic displays). All information provided through various services, regarding a certain stop position, is displayed on the web and app.

The council's traffic control center works together with local transport operators to manage an extensive network of roads, tramways and bus lanes to ensures smooth traffic flows. Traffic management center is collaborating with IBM researchers to enable the Big Data streaming for array of sources - bus timetables, inductive-loop traffic detectors, closed-circuit television cameras, and GPS data (GPS data from all the city's 1,000 buses is transmitted every 20 seconds). The city goal is to build a digital city map overlaid with the real-time positions of Dublin's buses using stream computing and geospatial data.

This means that the traffic controllers can monitor the current status of the entire bus network and rapidly spot and analyze problematic areas/situations by going into a detailed visualization of areas of the network that are experiencing delay. This approach can accelerate the decision-making process to clear congestion more quickly.

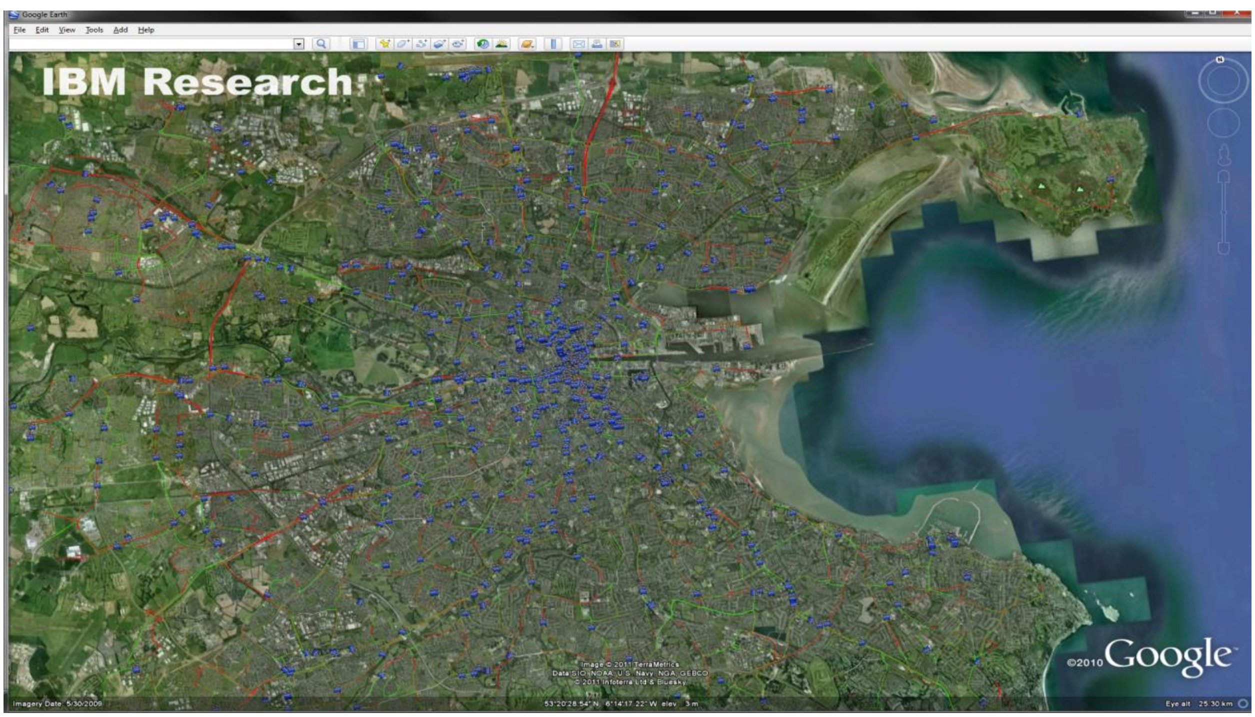


Figure 5.6 AVLC data used to show locations of buses

Additionally with improved reporting, the data can help TIMC to identify the optimal congestion alleviation measures. It is also helpful for decision makers to know whether the bus start their runs on time and whether there is a need to add additional bus lanes and other exclusive bus facilities. Use of the advanced analytics enabled discovery of the 'bus buching] problems when some of the buses are being passed on their routes by buses from the same line that departed at a later time during rush hour. Now, IBM researchers, the DCC, TIMC and city bus operators are working to determine why the distance and headways between busses are diverging in this manner and what measures can be quickly put into action that will improve traffic flow at these specific peak times.

5.3 Munich Traffic Management Center

City of Munich's TMC consists of two separate entities which are highly coordinated in operation: Urban TMC, whose jurisdiction is Munich's urban area and a TMC that is responsible for the freeway/highway operations. Interaction between city TMC and freeway TMC works seamlessly, protocols and regular meetings make this cooperation successful. Munich's TMC Planning Group is in charge of the major events preparations and ensures that all authorities involved in the execution of the event are adherent to the procedures in such cases. A small coordination center with the representatives of all authorities involved operates on a regular basis, ensuring that each event is carried out efficiently.

Munich TMC does not have traveler information system (US 511 system). There are different ways of providing traffic information to various city authorities, but the information is not, directly, accessible to private users yet. TMC does not provide Smartphone applications at this point. Various companies and city governmental offices have access to their information and through their own sources make them available to public (on their websites, through mobile phone applications, etc.). Highway Advisory Radio is present and operated by the regional TMC responsible for Freeway operations.

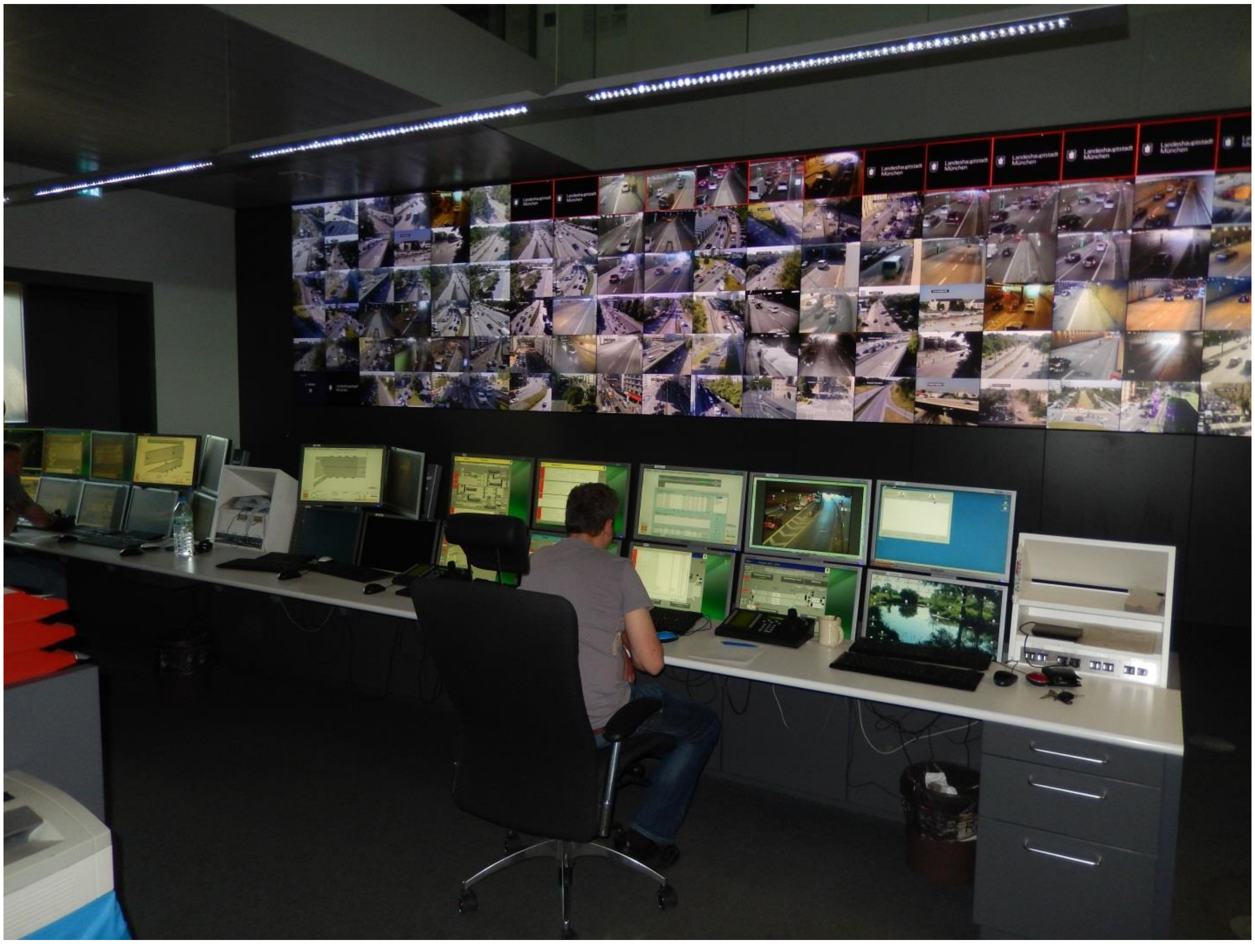


Figure 5.7 Munich TMC control room

There are representatives of three separate authorities within the Munich TMC ensuring the proper operation of the center: traffic control, police, and constructions sites and street lighting are parts of the TMC. These three entities are cooperating closely on daily basis and are able to interexchange information properly and quickly. However, even though information is available on websites of these authorities, the system does not provide an automatic integration of information. Currently, the City of Munich is in the process of purchasing a system which would allow for quick update and access to information automatically by traffic control operators in TMC. Information will include pre-trip and en-route information, transportation alternatives, and the optimizing of personal choice of means of transport.

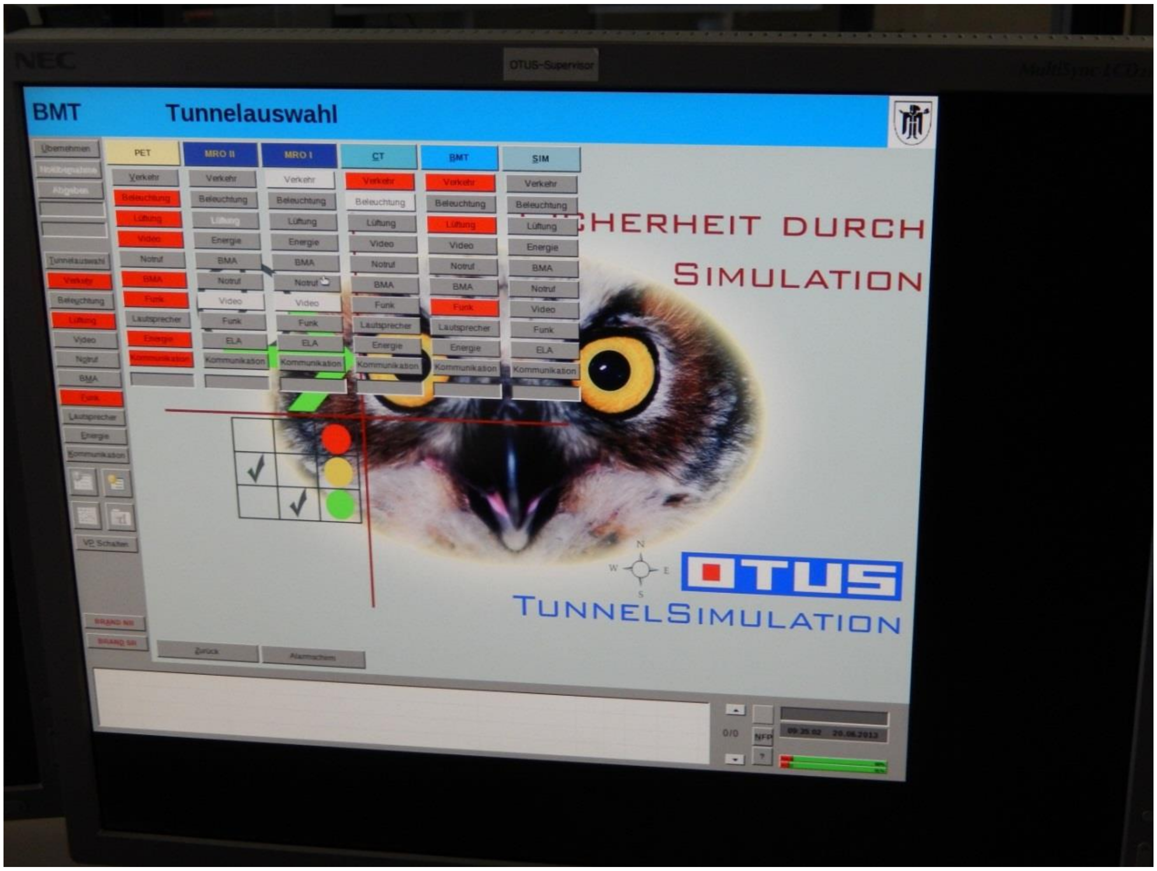


Figure 5.8 Tunnel selection for display

Munich TMC is not responsible for winter maintenance. However, trucks and equipment necessary for technical maintenance of road infrastructure are managed by the TMC. Dispatchers are collaborating closely with the meteorological information providers through a very sophisticated communication system.

TMC control room staff is in-house employed staff. There is no public access to traffic control information or any kind of data handled by TMC. Incidents, events, large gatherings, etc. is managed by the police, and these data are not accessible to the public. On the other hand, administration of construction information is available for private users by phone and internet. Traveler information services are provided through navigation system providers (Google, Tom Tom). City of Munich has installed vehicle detectors on the number of busiest intersections.

The emergency center is established for incident management operations. Public or traffic control operators inform the police regarding the potential or actual accidents on the road. The city Police is responsible for securing the crash location and removal of the wrecked vehicle and on site traffic coordination. In case of fire it is also their duty to request the fire brigade. TMC does not provide driver assistance (flat tire or no fuel).

Munich TMC possesses a sophisticated system for asset management. All the information regarding any necessary maintenance or state of the infrastructure is stored within the existing database. The process of asset management is controlled by the department of construction.

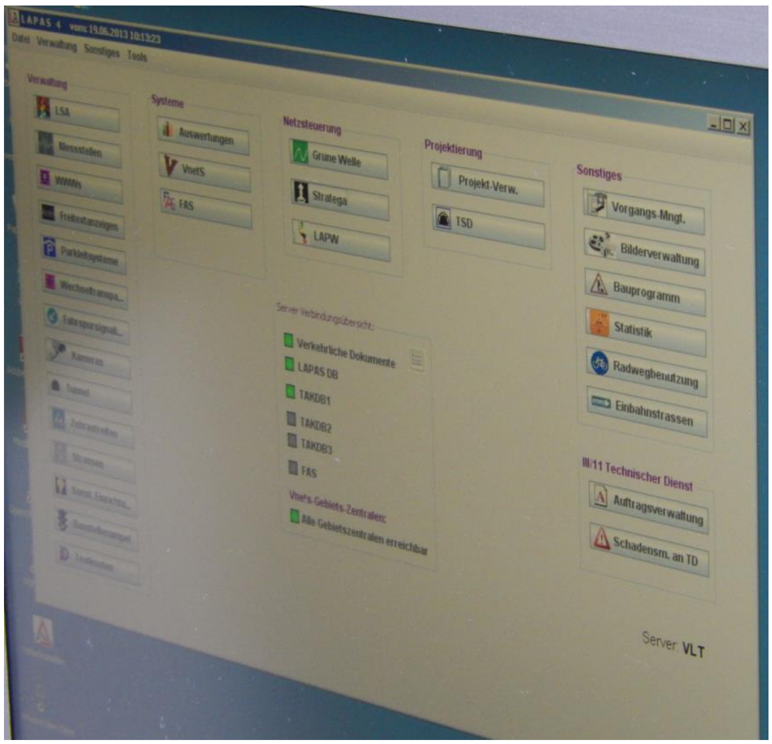


Figure 5.9 Asset management database

Every 20 to 25 years infrastructure components are being replaced. If the devices have faulty history they are replaced sooner. The replacements are carried out, depending on the current city budget. In Munich, there are many controllers that are 30-35 years old.
Traffic signal management software was developed in-house. TMC covers 1100 signal controllers, more than half of these are accessible remotely. The ones which are not available for remote control are operated manually, when necessary. Communication protocols for controllers consist of high quality telephone cables and GPRS communication (470 Controllers). The rest of the controllers use rudimentary control cables. New controllers have been installed for the routes which operate public bus lines operate.

TMC runs constant monitoring of the traffic performance measures which offer information on the quality of traffic conditions as well. There is no fixed cycle (e.g. number of years) for retiming signals. Depending on user's complaints and the general observation of TMC's staff, the adjustments of signal timing for each controller are carried out. Smaller and simpler changes are done in house. More complex projects (more signals or specialized logic) is conducted by consultants.

Munich has very sophisticated standards for traffic control logic and design since its staff consists of a number of very knowledgeable traffic engineers. This enables them to perform smaller and simpler signal controller changes by in-house staff. Only more complex changes that involve significant city investments and necessitate specialized logic familiarity are performed by the consulting companies. Ramp metering is not common in Germany. There is only one location in the entire Munich city area where ramp metering is provided.

Authorization for work zone operations is done by the construction site authority of the city of Munich, which forms a part of TMC. Execution is done by the city of Munich if the work zone is established on public (city) roads. If the construction is done by the private constructor companies then execution and establishment of the work zone is their responsibility.

HOT/HOV lanes or toll roads do not exist inside the city area. Only Bus Lanes (and tram lanes) exist. However, exclusive bus lanes are not running along the entire bus route (or its significant segments); they are provided only at specific locations where special priority service can be given to the buses, e.g. to bypass critical points in the network.

Variable speed limits are used only in tunnels and on freeways. The tunnels are the only areas inside the city of Munich where variable speed limit signs are available and the only ones that are controlled by the TMC. Traffic control operators make the decision regarding the appropriate speed value to be displayed based only on their engineering judgment. Changes in speed limits displayed in tunnels are done 2 to 4 times a day.

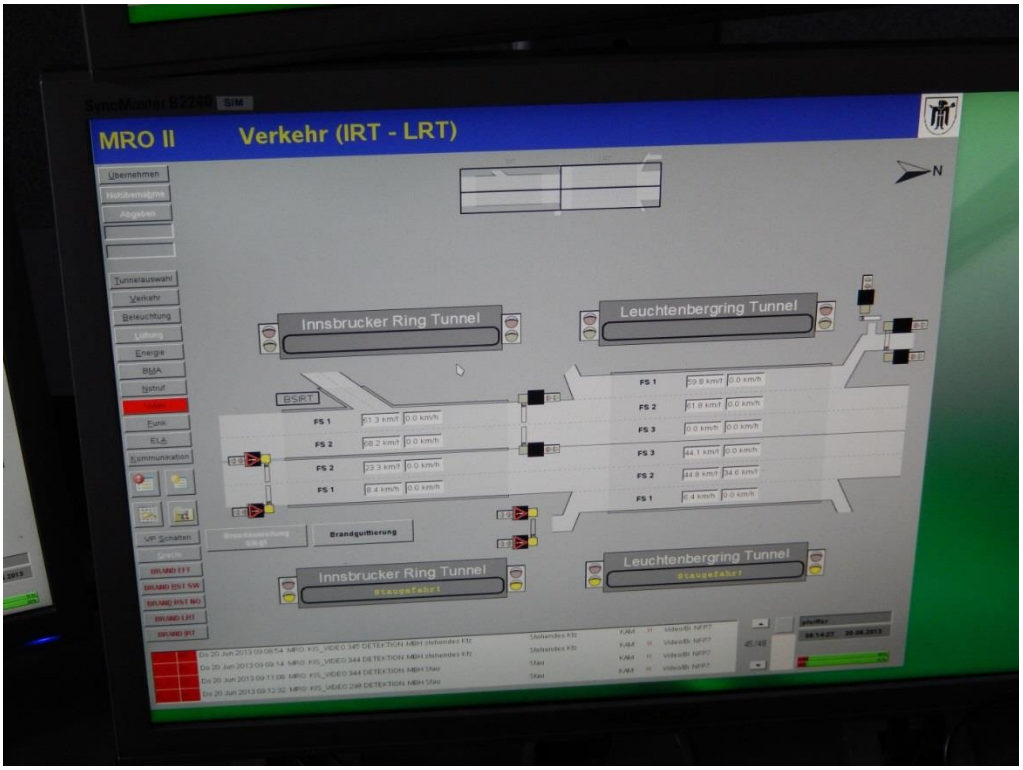


Figure 5.10 Variable speed signs displayed in tunnels

Management and operation of freeways is separated from urban TMC operations, and therefore freeway TMC has independent system for executing and displaying dynamic speed limits. Unlike the city TMC, they incorporate a sophisticated algorithm that calculates adequate speed limits in regard to traffic conditions at hand. These values are then confirmed by operators, and after approved, displayed in tunnels. Hard-shoulder running exists at many freeway sections. Variable Message Signs are used only in tunnels inside the city area. Freeway TMC authority has the power over the DMS/VMS displayed along the freeways.

5.4 New South Wales (NSW) Transport Management Center

NSW TMC evolved significantly since it was first opened in 1990, when it was traffic management oriented agency. Today, its main focus is transportation coordination among various transportation related entities and communication of the transportation related topics to the public. It has been developed into a TMC for Sydney and NSW. TMC monitors and manages the New South Wales 180,000 km road network 24 hours a day.

An integrated approach is established since effective traffic management includes multi agency cooperation that relies heavily on communication, co-ordination and close partnerships with other services and communities. The TMC consists of three core services: Traffic management of incidents and events, Traffic information and Network operations.

Figure 5.11 Transport operations room (TOR)

Transport Operations Room (TOR) is operated 24 hours a day by staff working two 12-hour shifts. Main features of TOR include:

- Central Management Computer System (CMCS), core of the TMC, which integrates all the operating and intelligent traffic management systems. CMCS analyses field data and the affected area and based on the information processed, the operators are advised to employ predefined response plans, which include controlling VMSs, VSL signs and CCTVs.
- Video switching system which allows for more than CCTV mounted across NSW to be viewed and remotely controlled.

- 24-panel video wall, along with 30 additional monitors available for displaying maps, computer-based graphics and reporting.
- Eighteen operator consoles that allow access to real-time traffic information.
- Integrated voice-based communication which permit managing phone calls and radio traffic across RTA and police radio networks.

Street Finder is the Roads & Traffic Authority RTA-developed software which provides fast access to geographic information and allows TMC staff to quickly locate intersections, streets and suburbs by displaying images, aerial photographs or street maps, as well as specific transport maps such as Traffic Emergency Patrol and clearway towing routes. TOR staff is specialized and highly trained; typically has emergency management and military background. Traffic operations room includes 43 senior traffic operators.

5.4.1 State-of-the-art tools

NSW TMC employs a number of different tools to manage the traffic flows. Over a thousand VMS/DMS and speed MS, also the TMC uses tidal flow arrangements and over 4000 SCATS intersections.

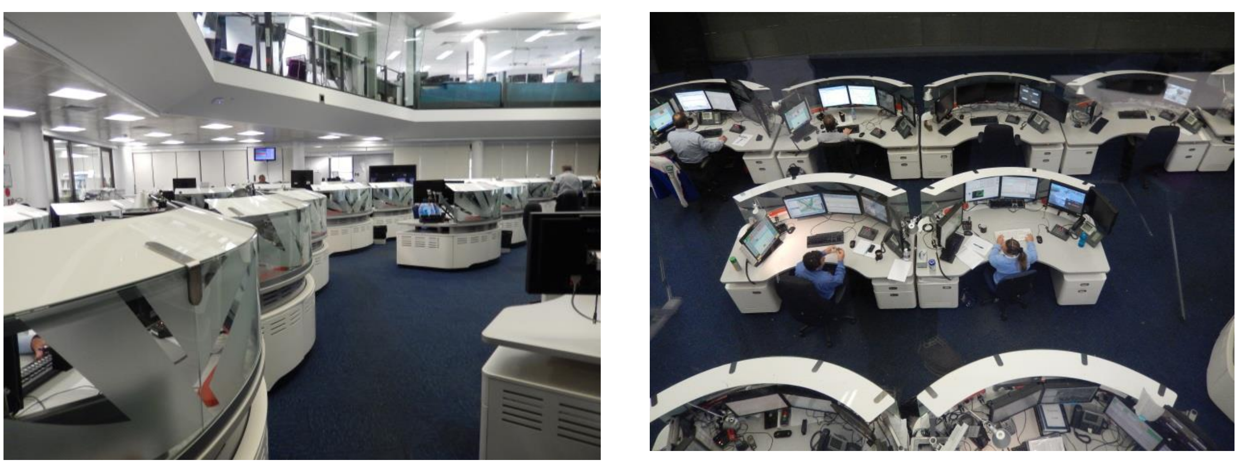


Figure 5.12 TOR operators at work

5.4.1.1 SCATS

TMC manages traffic signal network by employing Sydney Coordinated Adaptive Traffic System (SCATS). The system is able to react to changing traffic conditions by adjusting the phasing of each traffic light cycle. More than 4000 traffic signals are coordinated, monitored and managed by SCATS in NSW. Traffic flow and volume are measured by counting vehicles and the gaps between vehicles as they pass over the detector at each intersection. Regional computers analyze this information, calculate the best possible traffic signal timings, coordinate intersections, and adjust the signal times accordingly.

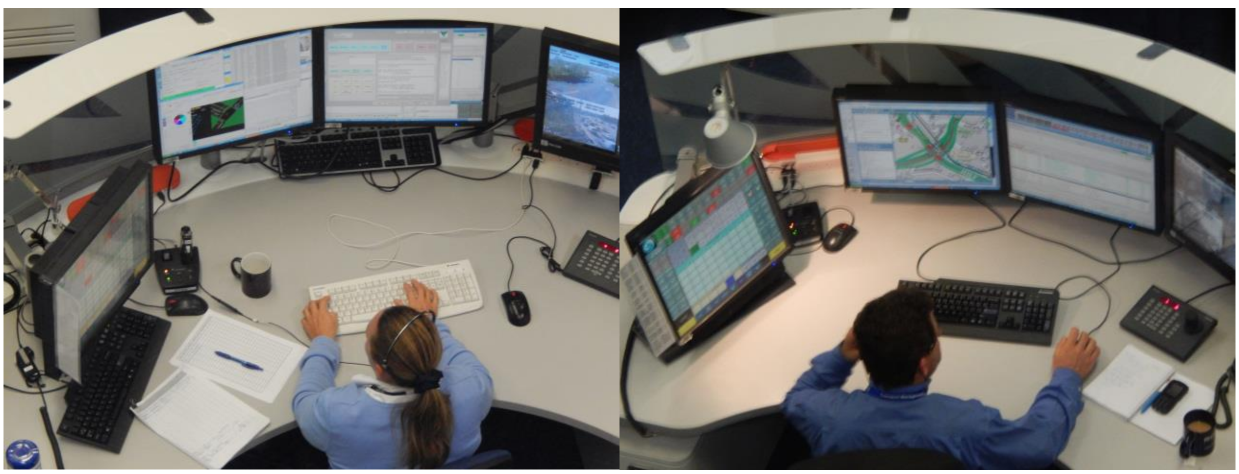


Figure 5.13 SCATS manages NSW roads

In heavy congested traffic the gaps are very small and SCATS would calculate those gaps and allocate more time to the approaches which necessitate them. SCATS would detect this demand and it would allow for a phase to get green time instantaneously. It detects minor changes in traffic and can adjust to that.

TOR operators can manually override the automatic operation if required; for example, when managing traffic around incidents. If a problem occurs, such as faults or failures in detectors or traffic lights the system provides an automatic alert service. SCATS can be managed using a single PC and managing up to 250 intersections, or it could manage a computer network with 8,192 intersections, through a central server.

5.4.1.2 Tidal flows

Major Sydney roads follow predictable patterns depending on the time of day. In order to increase the number of available lanes during peak hours and maximize traffic flow, tidal flow traffic systems were established. Four automatic tidal flow systems exist today in Sydney: at Neutral Bay (Military Road), Sydenham (Princes Highway), Kyeemagh (General Holmes Drive & Airport Tunnel) and the Sydney Harbor Bridge (SHB).

Several automated systems are responsible for providing effective and safe change in traffic direction. The Electronic Lane Changing System (ELCS) controls the flow of eight lanes of bridge traffic and is managed remotely from the TMC by dedicated SHB traffic controllers. ELCS integrates the use of electronic overhead signage, automatic movable medians and in-pavement lighting to adjust traffic direction an average of five times per day in four different configurations. TOR personal uses 127 movements to put the bridge into a specific position.
Main features of this system are motorized and movable medians, pavement lighting, overhead lane lights and electronic signs.

Figure 5.14: Peak hour tidal flow system on the Sydney Harbor Bridge

Traffic monitoring throughout Sydney and other parts of NSW, as well as Pacific Highway is achieved with over 700 CCTV cameras. Video switching system connects the CCTVs with the TOR. The cameras can be remotely controlled from the TMC and have the capacity to pan, tilt and zoom. TMC operators, by employing CCTV cameras are able to observe crucial traffic areas, respond to incidents and adjust traffic flows if required. Sydney Harbor Bridge, Sydney Harbor Tunnel, ANZAC Bridge and the M4 Motorway are regarded as higher risk areas and CCTVs in these areas are utilized to detect incidents. TMC also has the capabilities to exchange relevant images with other agencies if needed; in case of an incident or major event.

5.4.2 Web-based information

Providing accurate and timely information to transportation system users is one of the main tasks of the TMC. TMC uses a range of channels to communicate the information to the external users regarding disruption of services.

Live traffic website and app are updated 24h a day, by the TMC software; since Internet is recognized as a primary information communication tool to receive and deliver real-time information. Primarily incidents in the NSW area as well as upcoming roadwork are displayed providing valuable information when planning a trip. Also twitter accounts are available and they offer information regarding live traffic, trains, buses and ferries as well.

The most appropriate way to provide valuable information to the motorists is via radio, and the best way to provide the media with real-time relevant data is internet. Incident Reporting Internet Service provides a 24-hour web-based information service. IRIS is specifically suited to accommodate radio stations. There are regular radio reports that are distributed over a number of radio stations across Sydney and NSW.

TMC also encourages people to report incidents via phone calls. 131 700 is the number of the TMC's phone line reserved for the people to report traffic related incidents. Significant number of incident reports originates from these public sources. As soon as the call is received the operator is able to send an alert to the emergency crews of traffic incidents. Real-time traffic information can be obtained at any time through the Traffic Information Line 132 701. Traffic Information Line is updated 24 hours a day and the information available include vehicle accidents, road closures, major roadwork and special events. A road user can also speak to an operator if needed.

5.4.3 Variable message signs

Upon receiving an important traffic related information, a network of around 1000 Variable message signs (VMS) and variable speed limit signs (VSLS) is programmed and remotely updated in the TOR. VMS and VSLS are strategically placed around Sydney and linked to the TMC. Depending on the type of incident, weather conditions or special event, controllers change automatically speed limits and place adequate electronic signs.

5.4.4 Incident management

Traffic Commanders and Traffic Emergency Patrols (TEPs) are on the road 24/7, ready to provide support when incidents occur. Traffic Commanders and TEPs are patrolling Sydney, with additional resources employed in regional NSW. Responsibilities of Traffic Commanders include: collecting information and relaying it to the TMC; requesting traffic management resources and coordinating them at incidents; managing traffic around incidents; liaising with other agencies such as the Police and Fire Brigade; and helping clear the roads and normalizing surrounding traffic flows. Emergency patrols are equipped and trained to assist in emergencies, set up traffic controls and signs and helps clearing the incident.

An incident reported to the TMC gives the operator authority to dispatch any of the available vehicles in the field. Freeway response team is the response unit set up to resolve the matter of incidents on the freeway. This unit has heavy tow and light salvage vehicles, two traffic emergency patrol vehicles and two traffic monitoring vehicles dedicated to the freeway full time; they are responsible for clearing breakdowns and incidents at key locations.

NSW police department has had their officers in the TMC since its inception. Important feature because when an incident occurs on the main road or the highway the police is the first one to respond and implement the initial traffic management strategies. Police liaison officer monitors the incidents as they occur and if necessary sends a request to the police department to attend those scenes and work in coordinated operation with field partner agencies.

Operation free flow established in 2012 represents dedicated high visibility presence, where highway patrol cars assign to the vehicle a specific path of the freeway and/or highway network around Sydney. Motorcycle response team was another initiative introduced in 2012. The team is made of highway patrol trained police motorcycles that monitor the central business district (CBD) in dedicated sectors.

5.4.5 Special event management

Major events team has a primary role in planning major events. They work closely with counsel of venue organizing of NSW police and their main task is to minimize the impact and disruption to local residents, businesses, hospitals and the emergency services. Special event management is also responsible for encouraging people to use public transport when major events are scheduled.

A number of activities need to be completed before the actual road closure takes place: special event clearways to help maximize efficient traffic flow around events, special traffic arrangements which include posting signage and adjustment of signal timing, informing the public through every available means of communication (Internet, traffic information lines, advertisements). Also VMS boards are posted around Sydney city area to provide information about different events coming up. On the day of the event VMSs inform motorists about the detours. During major events particular consideration is given to the special vehicles (such as organ deliveries). Green light corridors are deployed to enable fast and safe road transport for special vehicles.

5.4.6 Interagency cooperation

TMC is cooperating closely with other government agencies and service providers, including the NSW Police, NSW Fire Brigades, the Ambulance Service of NSW, State Emergency Service, State Transit Authority (STA), Ministry of Transport and Local Government Authorities.

To facilitate efficient bus travel along major roads, STA and TMC are responsible for several bus priority initiatives. Priority settings consist of red bus lanes, transit lanes and bus stop bays bus lanes, clearways and transit signal priority. Recently, Public Transport Information Priority System (PTIPS) has been implemented. The purpose of this system is to enable priority and longer green times for buses running late by integrating bus service information and timetables with SCATS.

STA has 17 radio operators stationed in the TMC's TOR. Their responsibility is to monitor traffic conditions and disseminate acquired information to bus drivers. Train locating system and CCTVs, located in the TMC, enable the personal to track each train in the system observe the situation at hand, as well as train delays. Rail Liaison manager in the TMC is in charge of delivering relevant information to the media spokesperson in order to be delivered to the public in real time.

5.5 City of Portland TMC

Region 1 TMC is serving the Portland metropolitan area including all of Multnomah County, Washington County, Clackamas County, Columbia County, and Hood River County as well as eastern segments of Clatsop and Tillamook Counties.

TMC employs 575 people; dedicated, professional staff working in concert to maintain a safe and efficient transportation system. TMC strives to enable a multi-modal transportation system; this means highways, transit, rail and bicycle and pedestrian facilities all working compatible together in keeping people and goods moving.

The TMC operates 24 hours a day, 7 days a week. Their assets include over 100 highway cameras, 12 permanent variable message signs, approximately 140 ramp meters, eight ODOT incident response vehicles (Corridor Management Teams-COMET).

Winter maintenance crews are responsible for keeping the highways clear of snow and hazardous debris. Web site www.tripcheck.com is TMC's state-of-the art intelligent transportation system which displays color coded speed map, network of highway traffic cameras and other useful traveler information. Traveler information provides current and forecasted traffic conditions reported via web site, 511 phone system, dynamic message signs, highway advisory radio or personal in vehicle navigation systems. Surveys show that information influenced travel decisions for 80 percent of site visitors.

Traffic incident management provides a coordinated, timely and efficient response to traffic incidents that block travel lanes, slow or stop travel and lead to unreliable travel times. Oregon Department of Transportation's Freeway Incident Management and the agencies which collaborate to ensure coordinate response capabilities clear blockages and reduce the likelihood of secondary crashes.

Currently promoted TMC initiatives include:

- **Shorter cycle lengths in downtown areas** which are more adequate for multimodal environments. The goal is to address the needs of all the transportation system users. Lower cycle lengths are also best with shorter block lengths because of the potential for longer periods of red to stack traffic up between signals. These short cycle lengths provide quick changes for pedestrians and limited progression for buses that stop every two, three or four blocks.
- **Bus Only Activated Transit Sign (BATS)** was activated by the City in cooperation with TriMet (Tri-County Metropolitan Transportation District of Oregon) at their request. The purpose of the sign is to warn pedestrians of a bus approaching from the left turn. The warning sign is a caution indication designed to support the pedestrian indication as this is an area where TriMet has complained of a considerable amount of people walking in front of their left turning bus when they have a Don't WALK indication.
- **Bike Box** is a designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase. The benefit is for the very busy bus traffic and right turning volume at the intersection. Other benefits include: increased visibility of bicyclists, reduced signal delay for bicyclists, facilitates bicyclist left turn positioning at intersections during red signal indication, groups bicyclists together to clear an intersection quickly, minimizing impediment to transit or other traffic etc.
- **Multimodal Traffic Management** strategies reduce travel times, decrease vehicle emissions and improve transit performance. Multimodal Traffic Signal Innovations in Portland include: Priority for bus and trucks, preemption for Light rail transit (LRT); Application of adaptive signal control; Experimental signals for bikes; IntelliDrive concept implementation.
- **Adaptive signal timing**, which adjusts to real-time traffic flow, was employed and as a result, average travel time along the corridor decreased, benefiting automobiles, trucks and buses. Coordinated traffic signals decrease vehicle emissions and fuel consumption. The City of Portland updated signal timings for 145 traffic signals and realized

significant CO2 reductions, resulting in health and environmental benefits across the region.

- **Other Federal Highway Administration (FHWA) initiatives:** IntelliDrive concept implementation: GreenDriver app

Figure 5.15 Green Driver app

Green Driver is an inexpensive and easy-to-use tool that transmits fuel efficiency data to the driver's iPhone or Android through a blue tooth adaptor that is connected to the vehicle's onboard computer. This information is then translated into an intuitive readout that teaches drivers how to drive in a way that makes their cars as fuel efficient as possible.

- **Integrated Corridor Management (ICM)**

The ICM initiative is intended to demonstrate how intelligent transportation systems (ITS) technologies can efficiently and proactively manage the movement of people and goods in major transportation corridors.

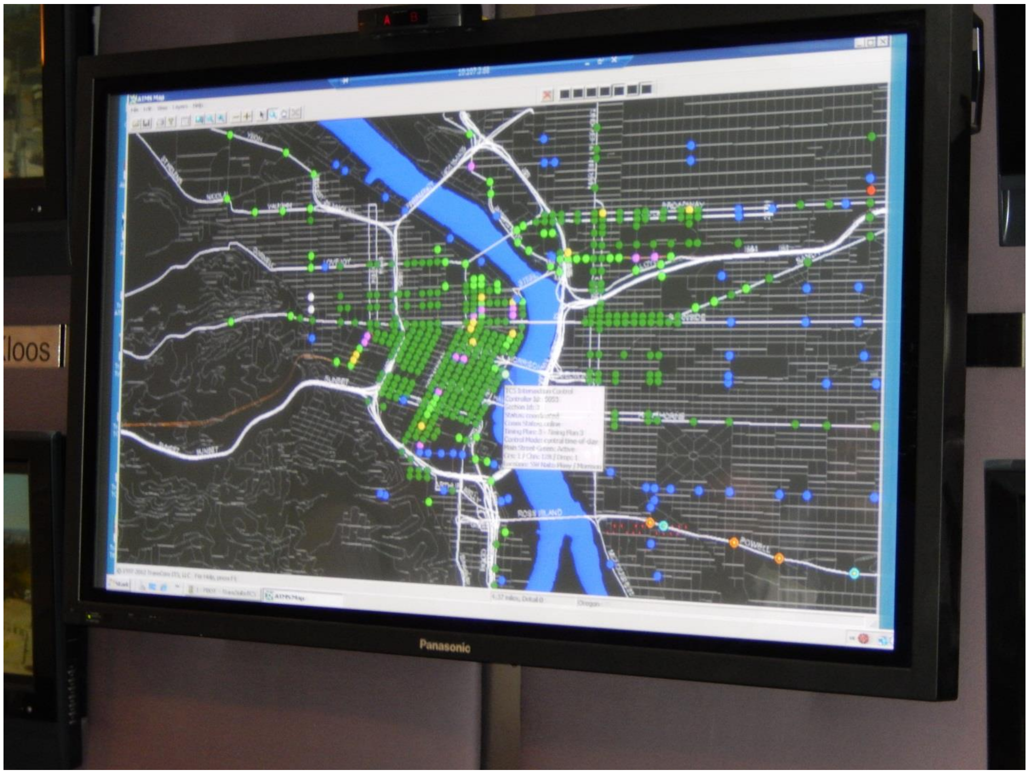


Figure 5.16 ATMS MAP-ICS Intersection Control

SCATS was installed on a main urban arterial corridor (Powell Boulevard, Portland OR) to help decrease overall vehicle delay and to achieve other performance measure benefits such as reduced traffic emissions. The optimization of traffic flow with this system can lead to an unintended increase in pedestrian crossing delay resulting in increased jaywalking and complaints. To balance the transportation planning goals of reducing congestion and emissions along with meeting the needs of pedestrian road users, a twenty second reduction in maximum cycle length was tested over two-weeks with concurrent monitoring of roadside air quality and travel time measurements throughout the testing period. This study assessed the changes in travel time and roadside air quality during the two-week testing period compared to before and after the change in maximum cycle length.

Assessment of air quality (based on NO and NO2 levels) and travel time for this roadway suggests that a twenty second decrease in maximum cycle length to help shorten pedestrian delay can be made without significant consequences to travel time and air quality.

Figure 5.17 Emission modeling equipment

5.6. Tokyo Traffic Management Center

Tokyo traffic management center is the world's largest traffic management center based on number of traffic signals controlled at one location. Three essential services provided by TMC are collection and analysis of traffic information, supply of traffic information to road users and traffic signal control.

Since transit agencies are considered private they are not allowed to be present in the TMC. Transit agencies essentially get the same information that the public does through the feedback gained from police.

Figure 5.18 Tokyo TMC control room

Traffic management center screens are each 50" and were installed over 15 years ago; TMC has 144 50-inch monitors. The system is 6 high and 12 wide and there are additional 6x6 screens on either side of the huge one.

There is a system similar to 511 that receives/provides the information over the phone to the public. The traffic message board technology is very widely used throughout Tokyo metropolitan area. Up to date radio traffic data broadcasting is available for private users.

They use a great number of ultrasonic detectors (12,000 of them in all) that provide the real-time performance for the entire system. The travel speed is updated every 50 seconds from the detection. Aside from ultrasonic vehicle detectors there are optical vehicle detectors (infrared beacons) and image processing vehicle detectors. The quality of the data they use daily is high because the detectors provide better resolution of the data. Direct manual control of signal timing is achieved inside the TMC.

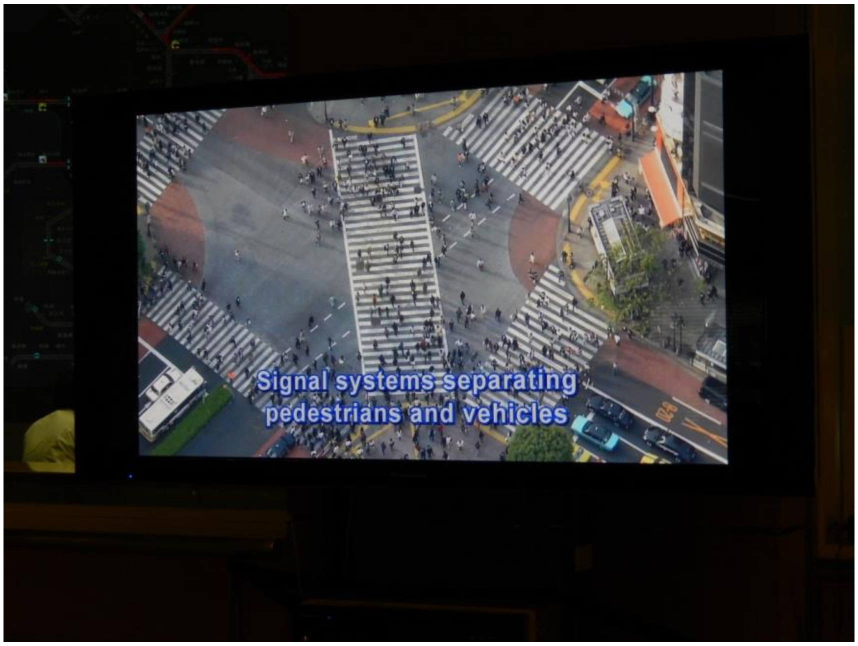


Figure 5.19 Separate phasing for pedestrian traffic

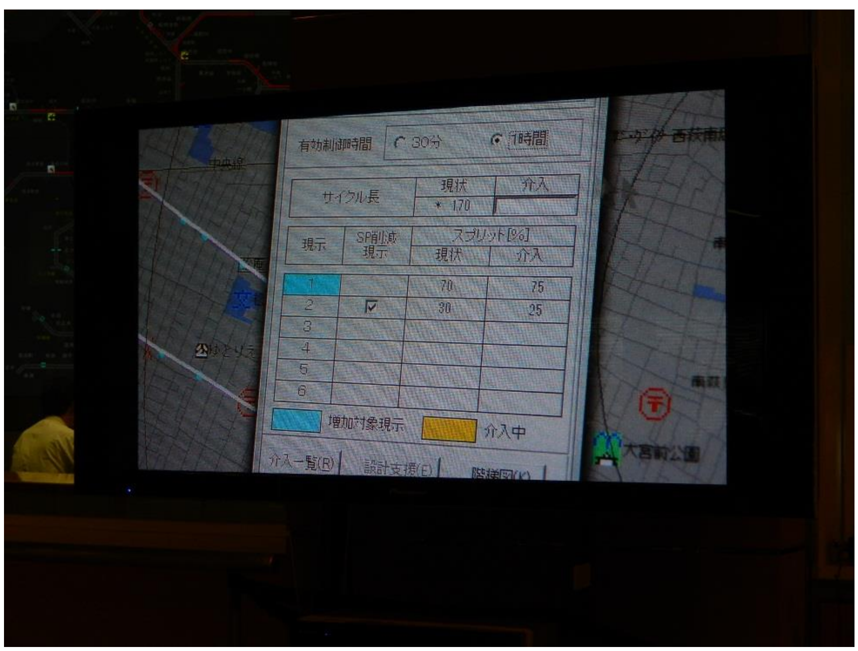


Figure 5.20 Signal retiming accomplished from inside TMC

5.6.1 Strategic Real-time Control for Megalopolis-Traffic (STREAM) System

The Advanced Traffic Control System of Tokyo Metropolitan Police Department, a system designed to handle traffic control in the twenty-first century, was completed and put into operation in February, 1995. As part of this system a new signal control system called STREAM (Strategic Real-time Control for Megalopolis-Traffic) was designed and incorporated. STREAM aims to alleviate traffic congestion, distribute traffic and reduce the number of traffic accidents. It is applicable for all traffic conditions, from under-saturation to oversaturation.

As of April, 1995, STREAM had gathered information from about 16,000 vehicle detectors and was controlling about 6,800 signals. When there is light traffic, STREAM aims not only to reduce delay and stops but also to make the traffic flow safe by moderating the speed of vehicles. It therefore uses a tool to set up offset which corresponds to the cycle length and uses a pattern selection method for real time offset control.

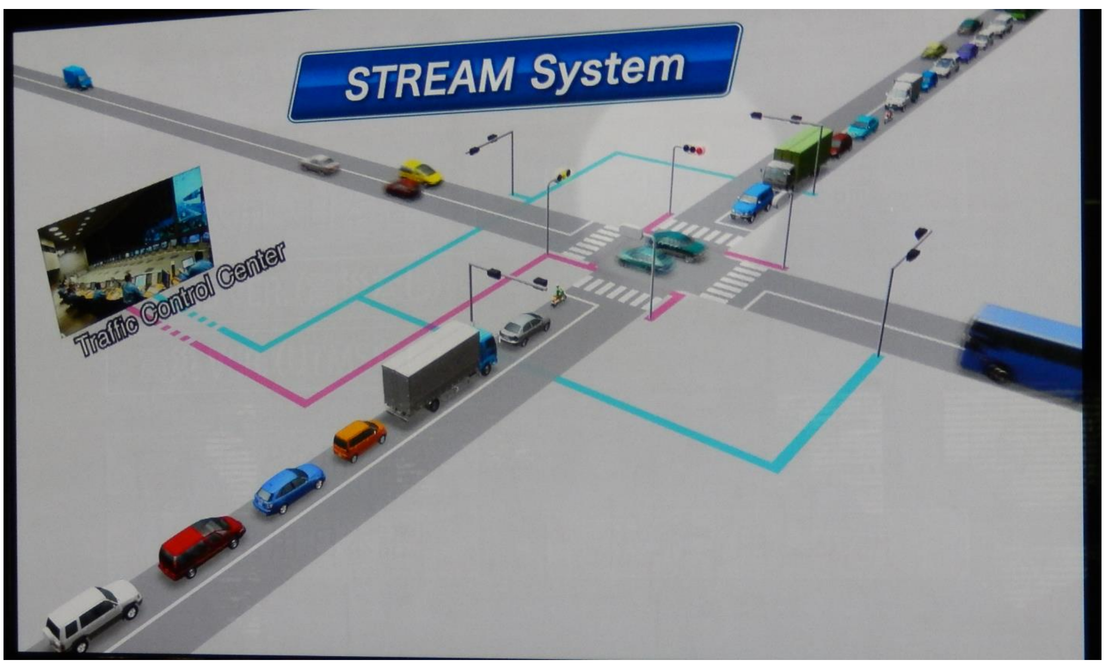


Figure 5.21 STREAM system outline

When traffic demand is nearly saturated, STREAM alleviates congestion by improving the efficiency of green time at critical intersections and maximizing the traffic capacity. It is provided with a critical intersection control method (Congestion Alleviation Control-CAC) for achieving this. CAC directly calculates the split and cycle length every 2.5 minutes based on the queue and traffic volume calculated from vehicle detector information. STREAM also incorporates right turn vehicle actuation which is run every second by a signal controller at each critical intersection.

When traffic demand is oversaturated, STREAM runs priority control for competing traffic flows at critical intersections. If congestion has exceeded a certain limit within a specific area such as the city center, STREAM controls inflow to that area. Priority control is made possible by the CAC function and inflow control.

A new traffic signal control system was installed using innovative vision sensors. In the demonstration, two vision sensors are installed diagonally at an intersection to measure the entire directional vehicle flow and pedestrians crossing the four crosswalks. The control algorithm is designed to optimize the balance of green time between vehicle traffic and pedestrian traffic as well as the split of vehicle directional flow.

Their vision sensor can integrate multiple loop detectors with highly flexible installation, and these advantages promise low-cost installation. The vision sensor measures vehicle and pedestrian flows simultaneously to maximize both benefits of pedestrian safety and vehicle flow efficiency.

The sensors are embedded in existing signal control of STREAM at the real intersections in Tokyo. Advantage of these sensors is their compatibility with the existing vehicle signal control systems. Vision sensors replace the existing multiple sensors for signal control such as loop detectors and ultrasonic detectors. These sensors represent a solution that is highly cost effective; it requires only easy installation and easy maintenance.

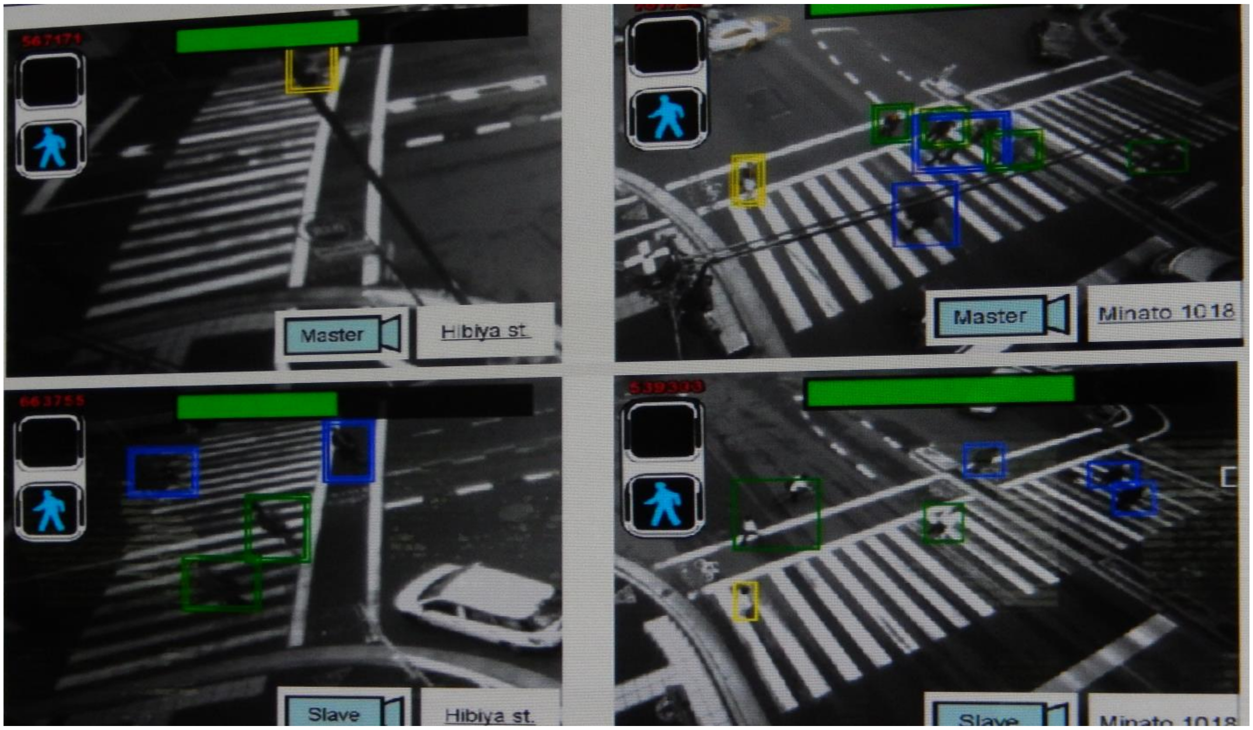


Figure 5.22 Pedestrian tracking via visual sensors

In some cases it is necessary to shorten pedestrian green for pedestrian safety i.e. pedestrians rushing into crossing cause pedestrian to vehicle collisions. In other it is necessary to extend pedestrian green time for pedestrian safety i.e. elderly and handicapped pedestrians, this is why sensors are used to measure velocities in order to detect slow pedestrians. Maximum pedestrian green durations and actual control results are determined by splits of vehicle signal.

5.6.2 Tokyo Metropolitan Government Disaster Prevention Center

Following the Great East Japan Earthquake the Tokyo Metropolitan Government (TMG) Disaster Prevention Center (DPC) strived to reconstruct the disaster preparedness measures. The DPC installed a disaster prevention system with the Disaster Countermeasure Headquarters as its center and deals with disasters along with the national government, municipalities, and other agencies based on information from the DPC.

The DPC has established the following initial response measures, during a catastrophic disaster, that would prevent large consequences. To respond at night and during holidays, the center has an after-hours communication office and accommodations for disaster management staff. Also, emergency government wireless systems are installed to secure system's collection/delivering information, seismometer network, supervisory video cameras, and a disaster information system to organize disaster related information.

In the event of a catastrophic disaster, the DPC sets up the "TMG Disaster Countermeasure Headquarters" (headed by the governor of Tokyo) in order to accomplish information gathering, firefighting, first-aid/rescue, etc. and implement them. The main objective of the disaster prevention plan is to employ its full potentials to prevent earthquake disasters in Tokyo and implement measures for emergency and restoration in order to secure citizens' life and their assets.

5.6.2.1 Preparedness measures for earthquake disasters

As for the earthquakes, the plan contains countermeasures to mitigate the effects of hazardous consequences. The plan focuses on mutual assistance, public involvement, improvement of the current crisis management procedures and developing a mechanism to support evacuees and promptly make the city return to its normal everyday operations. In addition, other measures include: increase of quake resistant rates in all structures (especially the structures along arterials), renovation of the structures so as to be quake resistant, development of an indication system in order to identify whether the buildings examined meet the quake-resistant standards. Special attention should be given to buildings close to emergency transportation roads (blockage in case of building collapse) and to buildings that were constructed prior to 1981 (according to old earthquake standards). For all of them resistant assessment will be provided, as well as financial support to reinforce the infrastructure. Also, fireproofing in wooden areas is being promoted.

Moreover, prompt medical care is being discussed in detail and most adequate emergency procedures described. The plan considers upgrading of the first medical care, transporting equipment and vehicles for the injured and better coordination of involved parties through upgraded information exchange system.

Seventy hospitals have been designated as disaster base hospitals for treating seriously injured. TMG appoints disaster medical care coordinators and local medical care coordinators in order to better distribute limited medical resources.

Another crucial issue are the lifelines primarily water and sewerage. The plan aims to make water and sewerage pipes as much as possible earthquake resilient and to restore quickly any piping failure.

Furthermore, when it comes to tsunami and high tides related emergencies, the TMG has established two sub centers High Tide response center and a sub center that is responsible for floodgates. Future plans consider making two response centers in case one of them is disabled by a disaster, the other one can continue operating remotely. To strengthen the crisis management countermeasures for coastal hazards TMG has established 50km of coastal levees and 19 flood gates.

Local communities and neighborhoods need to be included and contribute during the disaster through self-help and mutual assistance. Neighborhoods are being promoted and supported to continuously engage in disaster preparedness activities. A great deal of attention is given to the communication systems incorporated into the plan as informing the residents about all the resources available and providing instructions of any kind is vital for the successful execution of planned actions.

In coordination with TMG prevention Council Volcano Division measures have been established against volcanic disasters. They include observation system to monitor volcanic activities, disaster preparedness training and volcanic warnings and forecasts electronically through meteorological data.

Another type of hazards the plan covers are large scale accidents: nuclear disasters, large scale fires, accidents with hazardous materials that affect a large number of people etc. The disaster prevention plan includes all actions that should be undertaken in these occasions. Establishment of radioactive response teams, measuring of radiation levels as well as measurements of exposure dose in health institutions are some of the procedures included in the disaster prevention plan that deals with large scale accidents.

TMG Civil protection plan was developed to ensure evacuation of residents in the event of a terrorist attack. Also the new influenza virus future existence is anticipated and appropriate procedures determined to be followed in such case: voluntary ban on leaving home, vaccination implementation or temporary closure of facilities where groups of people gather (schools, companies, etc.).

In general, other countermeasures that the disaster prevention plan is considering are: expansion of telecommunication systems in public transportation for quicker reception of emergency related important information; strengthen ceiling materials in schools; strengthen disaster response by air with the installation of roof top helicopter signs on public buildings; agreement of TMG with logistics companies for prompt delivery of emergency supplies; development of stockpiles to ensure sufficient quantities of gasoline needed for emergency vehicles; cooperation with volunteers for execution of required actions; proposal of a mechanism of mutual assistance to people that would be unable to return to normal life. Issuance of certificate about the damage degree in order to assist and prioritize assistance according to the real needs.

6.0 A COMPREHENSIVE LIST OF HIGHLIGHTS

6.1 Minnesota DOT TMC

1. The MN DOT has a system manager who has a strong background in systems engineering and extensive knowledge of ITS technologies and devices which are deployed by the TMC system (both in the control room, IT room, and field).
2. VSL is advisory only.
3. ATMS software was developed in-house.
4. MN DOT is having controller compatibility issues switching from i2 to TACTICS.
5. MN DOT is considering a citizen reporting program for winter road conditions, similar to Wyoming.
6. The 511 phone system is outdated and will be replaced at some point by mobile phone apps and other systems.
7. MN DOT monitors ATMS system health through software with notifications.
8. MN DOT has a Highway Systems Operations Plan with operational needs assessed every 4 years and capital investment planned with a 20-yr horizon.
9. MN DOT has a policy for ramp metering of a maximum wait time of 4 minutes for on-ramps, and 2 minutes for system-to-system ramps. This balances queue management and mainline operations. Queue detectors are used to measure number of cars going in and detecting the end of queue. MN DOT is currently running a volume-based (capacity) ramp metering that adjusts metering rate every 30 seconds with available capacity. MN DOT wants to switch to a density-based algorithm (threshold should be 43 veh/ln/hour) with adjustment frequency of 6 seconds.
10. Natural light is valuable in the control room. Work stations have moveable work surfaces and individual climate control.
11. MN DOT thinks financial benefits obtained from sponsors are not worth name trade off.
12. It is important that at least two traffic controller manufacturers compete (for pricing).
13. Video wall is being upgraded to LCD flat panel displays, Work stations have moveable work surfaces and individual climate control, Control of video feeds and cameras is conducted by specially designed keyboards with joysticks, Control room uses natural light and acoustic ceilings.

6.2 Pennsylvania DOT TMC

1. The PENN DOT TMC manager has a strong system engineering background.
2. PENN DOT attends the “Operations Academy for Senior Management” at the University of Maryland and highly recommends the training.
3. PENN DOT has found a way to replace bulbs in projectors for much less cost (reusing the casings).
4. PENN DOT uses a visual classification system for winter road conditions, similar to the MUTCD approach for Level of Service.

5. The 511 phone system is outdated and will be replaced at some point by mobile phone apps and other systems.
6. PENN DOT contracts for all ATMS system maintenance, which allows system performance specifications to be enforced (96% uptime).
7. PENN DOT uses a performance-based traffic control spec. Contractor is not restricted on how many lanes can be closed as long as the delay does not exceed predefined delay limit. Performance measures such as detour travel times are used in conjunction with Bluetooth readers, cameras and other ITS devices to provide drivers with accurate work-zone delay estimates.
8. PA DOT has a fully-automated weather responsive (triggering) system to provide warnings in the early stages of a storm.

6.3 Ohio DOT TMC

1. ODOT has developed a training and certification program for traffic signal designers and technicians, which applies to internal employees and to consultants and contractors. Program curriculum is on their website.
2. ODOT combines ITS and signal maintenance.
3. ODOT has a proactive approach to ITS and signal maintenance. Devices have 5-year warranty and are replaced after 10 years with no repair.
4. Snow removal is coordinated through district dispatchers. Dispatchers interpret weather data from ScanWeb. Plow drivers are taught to interpret weather data also. Dispatchers run 24-hr blogs during storms to interact with maintenance crews.
5. ODOT uses an in-house developed software for ATMS management (Buckeye Traffic). Staff is used to program and manage software.
6. ODOT requires ATMS devices be maintained during construction, and imposes penalties for downtime.
7. ODOT uses INRIX to provide real-time work zone performance measures and work zone traveler information.
8. ODOT measures how much time it takes for speed to recover to pre-weather-incident speed. Their system triggers analysis based on RWIS data, which are combined with travel time data. OH DOT uses this recovery time (it takes during snow removal to recover to normal speed) as a performance measure of its operations during snow-removal operations.
9. ODOT's IMT program is completely privatized.
10. ODOT is considering adoption of a program similar to RISC (Rapid Incident Scene Clearance) program in Miami-Dade County, FL. The RISC Program is an incentive-based program that provides financial compensation for the complete clearance of major traffic events within specified time frames.
11. OH DOT has a practice of installing reflective aluminum back plates around signal heads (2" border) to increase signal visibility during nights and low-visibility conditions.
12. OH DOT has installed battery backup units at every signalized intersection.
13. OH DOT is unique for its ability to share and visualize RWIS data with truck operators, who are taught to know how to interpret numbers from RWIS reports.

6.4 Virginia DOT TMC

1. County fire dispatch is co-located with VDOT, VA State Police, and County sheriff.
2. Control room utilizes adjustable work spaces and was designed considering ergonomics.
3. TMC manager has a system engineering background.
4. All control room operators and supervisors are contracted.
5. A single vendor manages access to the data feeds from the TMC (video streaming and traffic data) and is responsible to distribute the data to all interested third parties. The vendor charges for the data released to the third parties and a part of that revenue comes back to VA DOT TMC.
6. The trend in 511 is toward Smartphone applications and other means to access information.
7. VDOT contracts out ITS maintenance.
8. IMT trucks are outfitted with mobile cameras that transmit over a 4G cellular network.

6.5 CALTRANS Sacramento TMC

1. They use a wind speed (25 mph) to trigger operators' actions.
2. Caltrans is looking into agreements with media companies (CBS, Clear Channel, etc.) who would provide full-matrix signs and (replace Caltrans VMSs) to provide full capability of visualizing commercial videos.
3. Caltrans wants to continue supporting 511 IVR and web applications.
4. Hard-shoulder running is implemented on arterial streets.

6.6 CALTRANS San Francisco TMC

1. The video wall consists of LED/LCD single-projection monitors manufactured by Barco.
2. Ramp metering functions are controlled through DELCAN's ATMS platform that allows for system-wide adaptive ramp metering.
3. The 511 centers have developed smart phone apps (which are free).

6.7 Kansas City SCOUT TMC

1. Genetec's Omnicast video surveillance system is supposed to be integrated in TransSuite.
2. SCOUT does not archive video but some shorter video feeds may be recorded only for internal training purposes.
3. Johnson County operates hard-shoulder running for buses during peak hours.
4. They provide numerous, helpful brochures to the public on aspects of TMC operations such as Ramp Metering, Operation Green Light, Incident Management.

6.8 Dublin TMC

1. Employs SCATS at 754 sites throughout Dublin and other parts of Ireland.
2. Developed DPTIM, which is interfaced with SCATS in order to provide transit priority and bus status information.
3. Dublin Port Tunnel project along with HGV City Cordon are instituted in order to promote HGV exclusion from the city's core.
4. RTPI system is available in Greater Dublin Area, while across major cities in Ireland Web Site and Apps are displaying information regarding 12,000 stops.

6.9 Munich TMC

1. Divides jurisdiction between Urban TMC (larger City of Munich) and TMC in charge of freeway/highway operation.
2. No 511 or similar system due to high security standards.
3. TMC is not responsible for winter maintenance.
4. Employs highly trained, knowledgeable traffic engineers and specialized staff; developed traffic signal management software in-house.
5. TMC possess a sophisticated system for asset management which stores any information regarding necessary maintenance or state of the infrastructure.
6. Ramp metering is not common in Germany.
7. Unlike city TMC, Freeway TMC operates a sophisticated algorithm that calculates adequate speed limits in regard to traffic conditions at hand.

6.10 Oregon TMC

1. Serving a very wide Portland metropolitan Area, encompassing 7 counties.
2. Strives to enable a multi-modal transportation system - highways, transit, rail, bicycle and pedestrian facilities all working compatibly together.
3. Promotes initiatives that include: shorter cycle lengths in downtown areas, "Bus Only Activated Transit Sign" (BATS), Bike Box, GreenDriver app, Integrated Corridor Management.
4. Updated signal timings for 145 traffic signals and employed SCATS on the main urban arterial corridor realizing significant CO_2 reductions, resulting in health and environmental benefits across the region.

6.11 NSW TMC

1. Multi-modal transportation oriented agency divided among 3 core departments: Traffic management of incidents and events, Traffic information and Network operations.
2. Main feature of the TMC is the Central Management Computer System (CMCS), which integrates all the operating and intelligent traffic management systems
3. Operates over 4000 SCATS intersections across NSW.
4. Four automatic tidal flow systems exist today in Sydney.
5. Electronic Lane Changing System (ELCS) controls the flow of eight lanes of bridge traffic and is managed remotely from the TMC by dedicated SHB traffic controllers.
6. TMC uses a range of channels to communicate the information to the external users regarding disruption of services: Live traffic website and app, radio and traffic information phone lines.
7. Highly sophisticated incident management system with response and patrol teams at CBD, wider city area as well as the freeway.
8. TMC is cooperating closely with other government agencies and service providers, which have their representatives working at TOR.

6.12 Tokyo TMC

1. World’s largest TMC based on the number of signals controlled at one place.
2. Transit agencies are considered private and are not allowed to have representatives in the TMC.
3. Radio traffic data broadcasting and a system similar to 511 is available for private users.
4. They use 12000 ultrasonic detectors that provide high quality real-time performance measures for the entire system.
5. Strategic Real-time Control for Megalopolis-Traffic (STREAM) was designed and incorporated as part of the Advanced Traffic Control System of Tokyo Metropolitan Police Department. STREAM aims not only to reduce delay and stops but also to make the traffic flow safe by moderating the speed of vehicles.
6. They began using vision sensors which measure vehicle and pedestrian flows simultaneously to maximize both benefits of pedestrian safety and vehicle flow efficiency.

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